# CITY OF PERRIS
Seismic Safety and
Public Safety General
Plan Elements

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Public Safety General
Plan Elements

Prepared by
Envicom Corporation

Adopted November 1976

Revised by Planning
Department Staff
December 1981

RESOLUTION NO. 940

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF PERRIS ADOPTING A SEISMIC SAFETY ELEMENT AND A GENERAL SAFETY ELEMENT TO THE GENERAL PLAN OF THE CITY OF PERRIS

WHEREAS, Sections 65302(f) and 65302.2 of the State of California Government Code require General Plans to contain a Seismic Safety Element; and

WHEREAS, Section 65302.1 of the State of California Government Code requires General Plans to contain a Safety Element; and

WHEREAS, the City of Perris entered into a joint powers agreement with the County of Riverside and the several cities for said element preparations; and

WHEREAS, pursuant to said agreement ENVICOM Corporation of Sherman Oaks, California was retained as geologic and general safety consultant to prepare said elements; and

WHEREAS, the Planning Commission of the City of Perris did receive said elements as prepared in combined form from ENVICOM, reviewed, corrected and revised same and did forward same to the City Council under formal resolution recommending adoption; and

WHEREAS, the City Council did conduct formal public hearing to solicit public participation; and

WHEREAS, the combined Seismic/Safety Element attached hereto as Exhibit A has been determined to satisfy all requirements of the law;

NOW BE IT RESOLVED, that the City Council of the City of Perris adopts said elements to the City of Perris General Plan this 29th day of November, 1976.

Robert [illegible]

MAYOR OF THE CITY OF PERRIS

I certify that the foregoing is a true and correct copy of the Resolution which was duly adopted by the City Council of the City of Perris at a regular meeting thereof duly held on the 29th day of November, 1976.

Pauline L. Rieder

CITY CLERK OF THE CITY OF PERRIS

CITY of PERRIS INCORPORATED MAY 26, 1911 RIVERSIDE COUNTY

MEMBERS OF THE CITY COUNCIL, PLANNING COMMISSION AND CITY STAFF
WHO HAD A PART IN THE PREPARATION OF THE SEISMIC/SAFETY
ELEMENT OF THE GENERAL PLAN FOR THE CITY OF PERRIS

City Council Members:

Robert D. Perry - Mayor
Donald D. Senger - Vice Mayor
Cleo Brown - Councilperson
James H. Adams - Councilperson
Floyd T. Johnson - Councilperson
Pauline L. Rusher - City Clerk

Planning Commission Members:

Dwight B. Minnich - Chairman
Carl Peterson - Vice Chairman
Norman Hughes - Commissioner
Harvey Spencer - Commissioner
Thomas Yanez - Commissioner
Eileen Abrams - Secretary
Susan Rehnke - Acting Secretary

Staff Members:

S. Vincent Erdelyi - City Manager
John L. Libiez - Associate Planner
L. O. Vanderford - Chief Building Inspector
Andy Millar - Superintendent of Public Works
Robert Gordon-Ross - Deputy Fire Chief
Nick Cadena - Acting Deputy Fire Marshal
Kiernan J. McAuley - Police Chief
Eugene L. Diepholz - City Engineer

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* City Staff Developed

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# I. INTRODUCTION

## A. Legislative Authority

The California State Legislature, through requirements of the Seismic Safety and Safety Elements, has placed specific responsibilities on local government for identification and evaluation of natural hazards and formation of programs and regulations to reduce risk, Specific authority is derived from Government Code Sections 65302(f) and 65302.1 which require Seismic Safety and Public Safety Elements of all city and county general plans as follows:

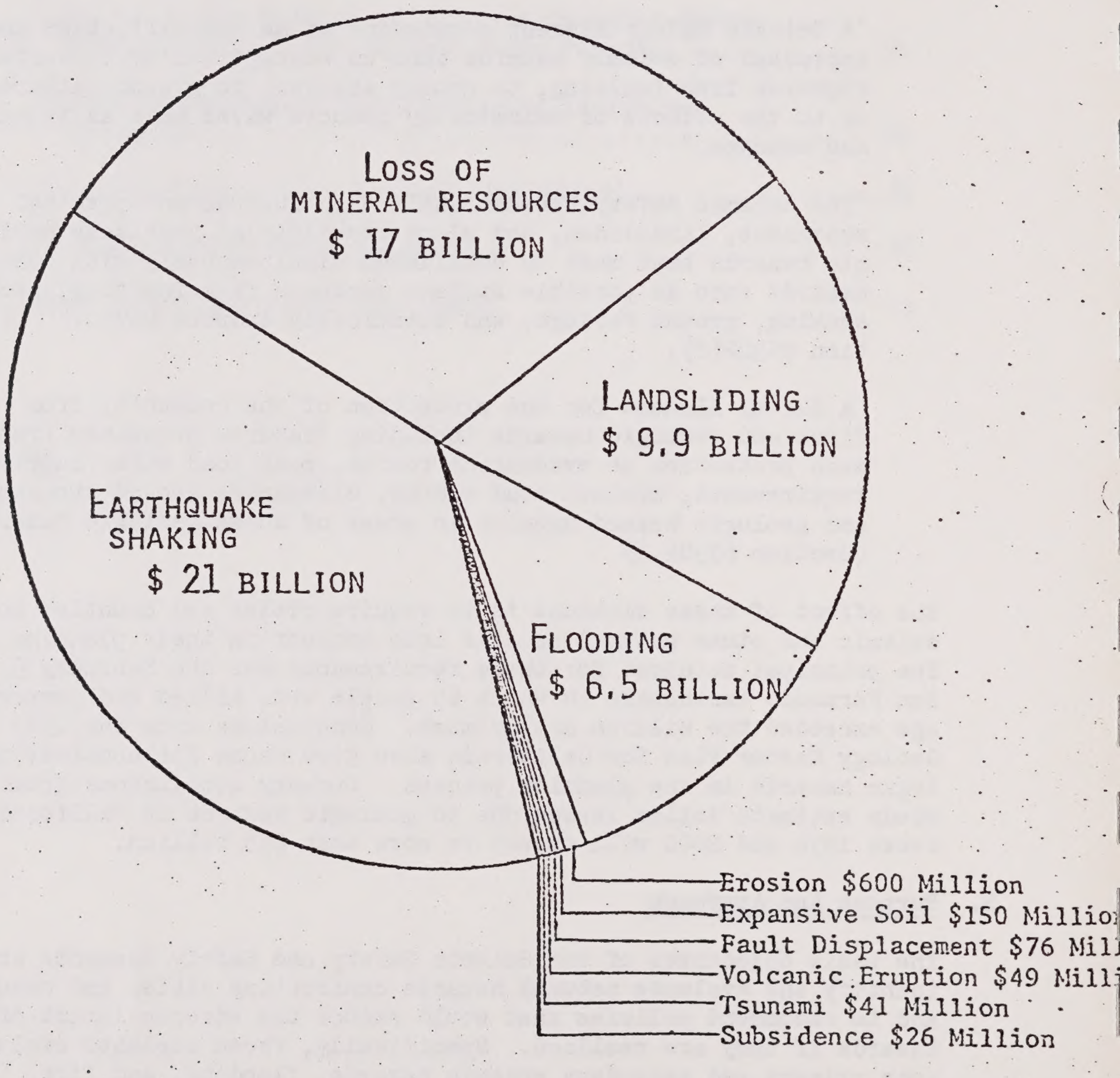
> "A Seismic Safety Element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches."
>
> "The Seismic Safety Element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure, and seismically induced waves." (Section 65302(f).
>
> "A Safety Element for the protection of the community from fires and geologic hazards including features necessary from such protection as evacuation routes, peak load water supply requirements, minimum road widths, clearances around structures, and geologic hazard mapping in areas of known geologic hazards." (Section 65302.1)

The effect of these sections is to require cities and counties to take seismic and other natural hazards into account in their planning programs. The principal catalyst for these requirements was the February 9, 1971 San Fernando earthquake in which 65 people were killed and property damage exceeded the billion dollar mark. Conclusions from the 1973 Urban Geology Master Plan for California also give cause for considering geologic hazards in the planning process. Summary conclusions from this study estimate dollar losses due to geologic hazards in California between 1970 and 2000 will amount to more than $55 billion.

## B. Purpose And Approach

The basic objectives of the Seismic Safety and Safety Elements are to identify and evaluate natural hazards confronting cities and counties and to recommend policies that would reduce the adverse impact of those hazards if they are realized. Specifically, these elements evaluate both primary and secondary seismic hazards, flooding, and fire. The intent of the recommended policies is to provide an opportunity to reduce the loss of life, property damage, and social and economic dislocations in the event of a major earthquake, flood, or fire.

GEOLOGIC HAZARDS IN CALIFORNIA
TO THE YEAR 2000:
A $55 BILLION PROBLEM




Source: Urban Geology, Master Plan for California, Bulletin 198, 1973.

The purpose of this document is to serve as an official guide to the City Council, the Planning Commission and other governmental bodies, citizens, and private organizations concerned with natural hazards in the City of Perris. The Seismic Safety and Safety Elements are intended to establish uniformity of policy and direction within the City government to minimize the risk from seismic events and other natural hazards. These Elements include goals, policies, safety criteria, and maps as a basis for decision making in public and private development matters. Such information should be used in conjunction with other established City policies contained in the General Plan, and should play a role in determining future land use.

The Seismic Safety and Safety Elements have been prepared as two reports for the City of Perris. The first is the County of Riverside Technical Report which contains a detailed presentation of the methods and findings regarding seismic, flood, and inundation hazards for the County as a whole. The second is this document which contains both a technical analysis of hazards at the local level (city-wide) as a supplement to the County report, and a recommended set of policies for hazard reduction. It should be noted that the sciences of seismology and fire ecology are relatively young and that much remains to be learned. The basic philosophy under which this document was prepared is that we should incorporate natural hazards analysis into the planning process based on what we know today, rather than waiting until we know all that we would like to know.

## II. EXISTING CONDITIONS

### A. Types Of Hazards

Three basic groups of natural hazards are considered in this document: seismic, flooding, and fire hazards. There are several types of seismic hazards which can be grouped in a cause-and-effect classification that is the basis for the order of their consideration. Earthquakes originate as shock waves generated by movement along an active fault. The primary seismic hazards are ground shaking and the potential for ground rupture along the surface trace of the fault. Secondary seismic hazards result from the interaction of ground shaking with existing soil and bedrock conditions, and include liquefaction, settlement, landslides, tsunamis or "tidal waves", and seiches (oscillating waves in lakes and reservoirs).

The potentially-damaging natural events (hazards) discussed above may interact with man-made structures. If a structure is unable to accommodate the natural event, failure will occur. The potential for such failure is termed a structural hazard, and includes not only structures themselves, but also the potential for damage or injury that could occur as the result of movement of loose or inadequately restrained objects within, on, or adjacent to a structure.

A more in-depth discussion of earthquake terminology and concepts is included in the Introduction of the Seismic Safety Element Technical Report, along with a Glossary of Terms in the back of the Report.

Flooding hazards in this report are considered in two categories: natural flooding and dam inundation. Natural flooding hazards are those associated with major atmospheric events that result in the inundation of developed areas due to overflows of nearby stream courses or inadequacies in local storm drain facilities.

Dam inundation hazards are those associated with the downstream inundation that would occur given a major structural failure in a nearby water impoundment.

### B. Technical Analyses

#### 1. Seismic Hazards

Geologic and Seismic Setting

The geologic setting of the Perris area can be simplified into two basic units. The hills to the west of the City are underlain by relatively hard granitic rocks ("A" on Plate I), while the valley at and to the east of the City is underlain by Pleistocene alluvium. The latter increases in thickness from zone 0-200 feet thick ("D" on Plate I) along the edge of the hills to thicknesses up to about 1000 feet to the east ("B" on Plate I).

The seismic setting can be characterized as one of relatively low hazard in comparison to areas to the east and north because of the greater distance from the San Jacinto fault zone. The main part of the City is in

Zone II while the valley to the northeast is in Zone III.

## Active and Potentially Active Faults

No active or potentially active faults are known to be present in the Perris area. A suspected fault located about one-half mile east of Highway 395 has recently been proposed by Moyle (1974) on the basis of a groundwater barrier. There is no specific data to indicate that this fault is active, and no specific governmental response is recommended at this time. However, the County Geologist should be alert to any new data from this area that may help resolve this problem.

## Earthquake Shaking

Earthquake shaking is expected to be moderately strong as a result of earthquakes generated by movement of faults within the San Jacinto fault zone. The zonation for earthquake shaking is discussed in the County technical report, and the boundaries of the zones are shown on Plate I. The general characteristics of the earthquakes are given in Table 1, and applicable response spectra are included in Figures 1 through 6.

## Secondary Hazards

Groundwater levels are generally at substantially greater depth than the 30 feet normally considered conducive to liquefaction. Settlement, however, may be a problem in some parts of the area in that the surficial sediments are somewhat similar to those near Hemet and San Jacinto where significant differential settlement has been reported. While no specific problem areas have been identified within the Perris area, soils engineers should be alert to this potential problem in conducting foundation investigations in the "B" or "D" zones.

Landslides and slope instability are a relatively minor hazard. The steeper slopes are underlain by granitic rocks, and the downslope movement of loose rock or boulders during strong ground shaking is the most likely slope hazard in the area. However, the potential for instability exists in all the hillside areas, and engineering geologic investigations are recommended for developments in these areas.

## Seiching

Seiching is not a significant hazard in the planning area except as they may affect water storage tanks on hillside locations above inhabited structures. No specific tanks have been identified as being a hazard, but tanks constructed in the future should be designed to take into account the levels of expected shaking at the applicable frequencies as defined by the spectra included.

## Conclusions and Recommendations

- No "active" faults are known to be present in the Perris area, but a possible fault, located about one-half mile east of Highway 395, is suggested by groundwater anomalies noted in recent work by the U.S. Geological Survey. On this basis, the fault could be considered "potentially active," but in the absence of more direct

TABLE 1

GENERALIZED CHARACTERISTICS OF EXPECTED EARTHQUAKES
PERRIS, CALIFORNIA

| Zone | g | T | t | S |
|---|---|---|---|---|
| | | Use Category B | | |
| II A | 0.33 | 0.1-0.2 | 10-15 | 1 x 1.25 |
| II B | 0.45 | 0.1-0.3 | 15-25 | 2 x 1.25 |
| II D | 0.55 | 0.1-0.3 | 15-25 | 3 x 1.25 |
| III A | 0.54 | 0.1-0.2 | 15-20 | 4 x 1.25 |
| III B | 0.72 | 0.1-0.3 | 20-30 | 5 x 1.25 |
| III D | 0.90 | 0.1-0.3 | 20-30 | 6 x 1.25 |
| | | Use Category C | | |
| II A | 0.27 | 0.1-0.2 | 8-12 | 1 |
| II B | 0.36 | 0.1-0.3 | 10-20 | 2 |
| II D | 0.44 | 0.1-0.3 | 10-20 | 3 |
| III A | 0.43 | 0.1-0.2 | 10-15 | 4 |
| III B | 0.58 | 0.1-0.3 | 15-25 | 5 |
| III D | 0.72 | 0.1-0.3 | 15-25 | 6 |
| | | Use Category D | | |
| II A | 0.19 | 0.1-0.2 | 5-10 | 1 x 0.7 |
| II B | 0.26 | 0.1-0.3 | 8-15 | 2 x 0.7 |
| II D | 0.31 | 0.1-0.3 | 8-15 | 3 x 0.7 |
| III A | 0.27 | 0.1-0.2 | 8-12 | 4 x 0.64 |
| III B | 0.37 | 0.1-0.3 | 10-20 | 5 x 0.64 |
| III D | 0.46 | 0.1-0.3 | 10-20 | 6 x 0.64 |

g = Maximum ground acceleration expressed as a decimal fraction of the acceleration of gravity
T = Predominant period of ground shaking in seconds
t = Duration of "strong" shaking in seconds
S = Figure number for applicable response spectra and amplification factor for spectral values

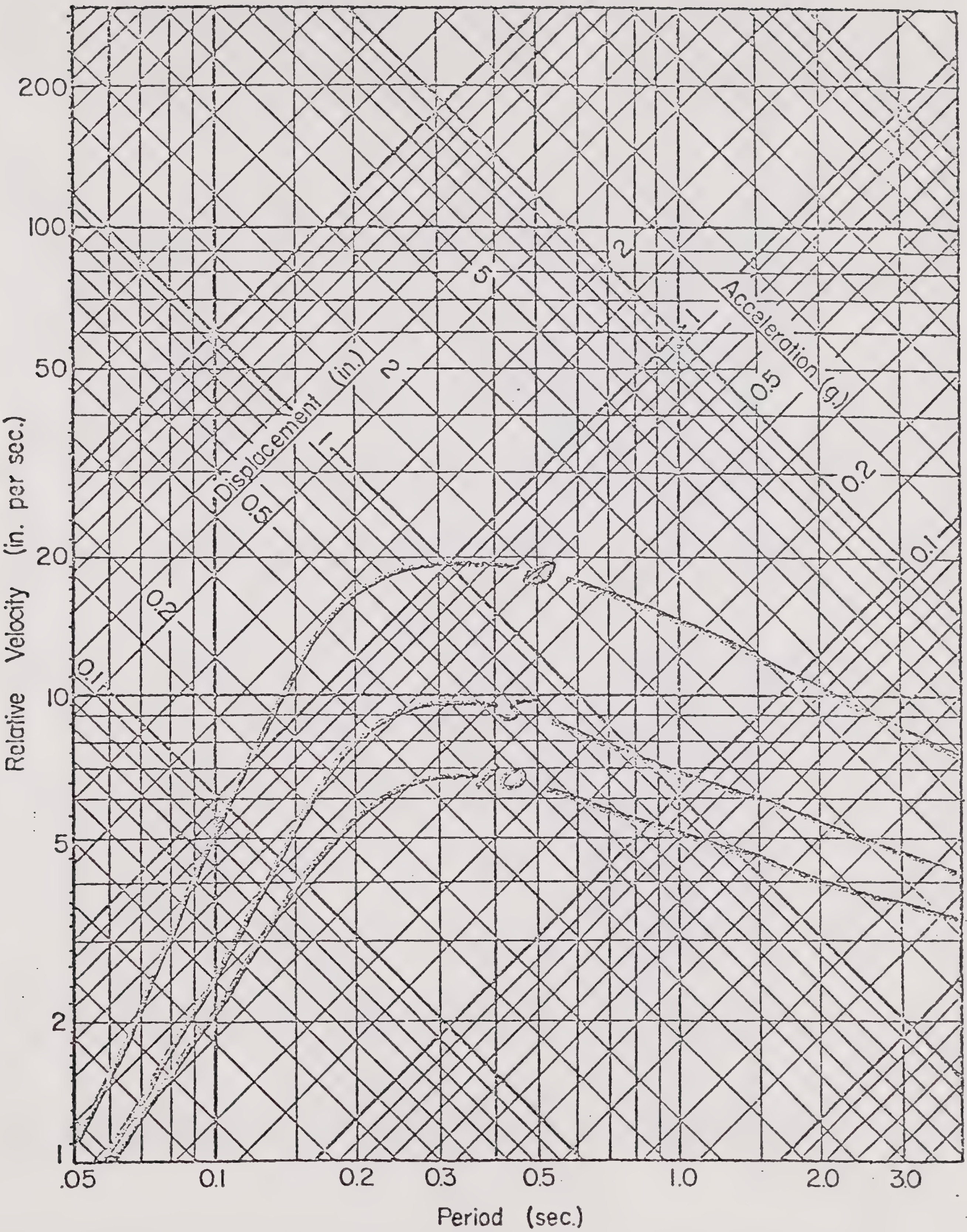



Figure 1. Response spectrum from Zone IIA. Curves are for 0, .5, and 10% critical damping.

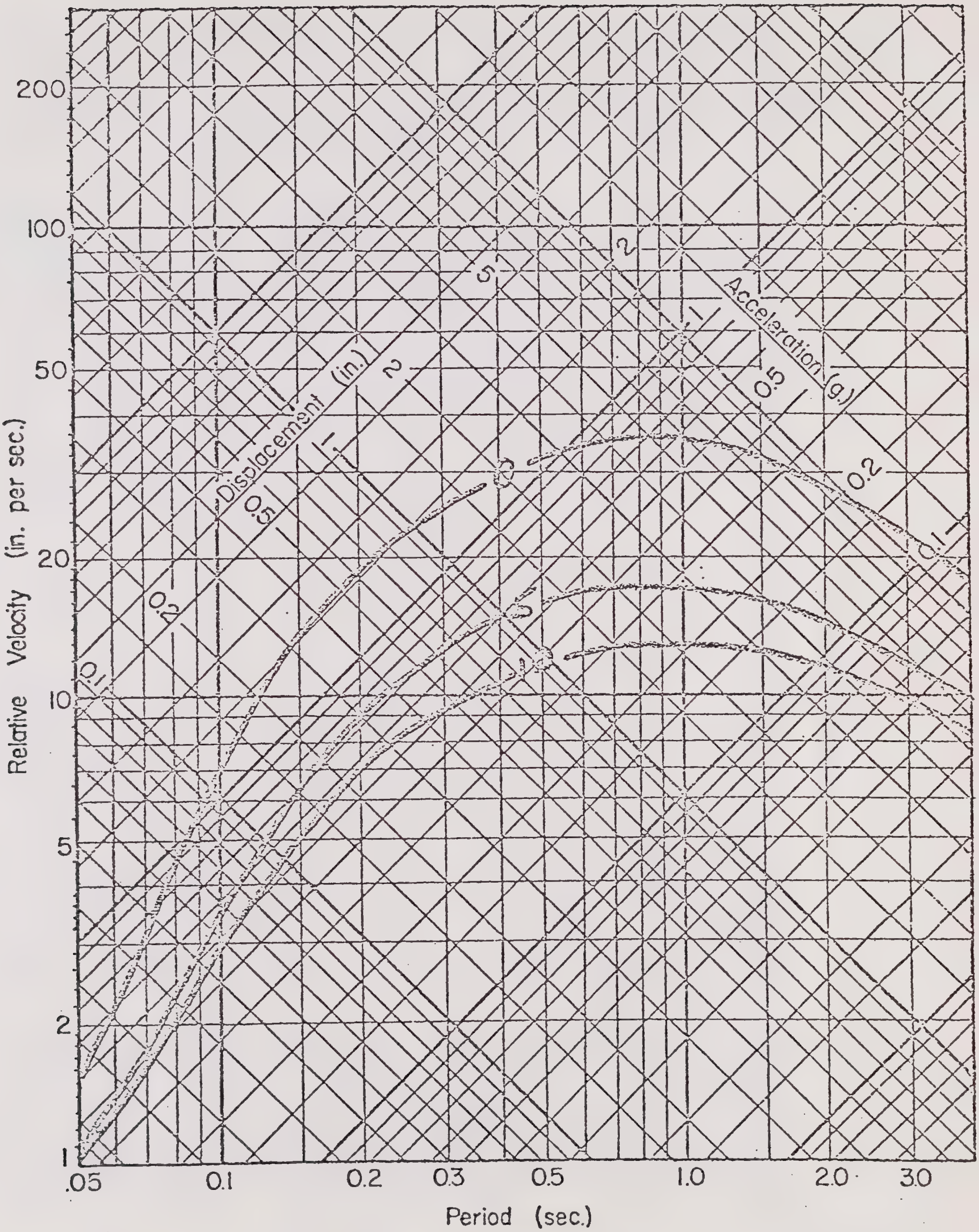



Figure 2. Response spectrum from Zone IIB. Curves are 0, 5, and 10% critical damping.

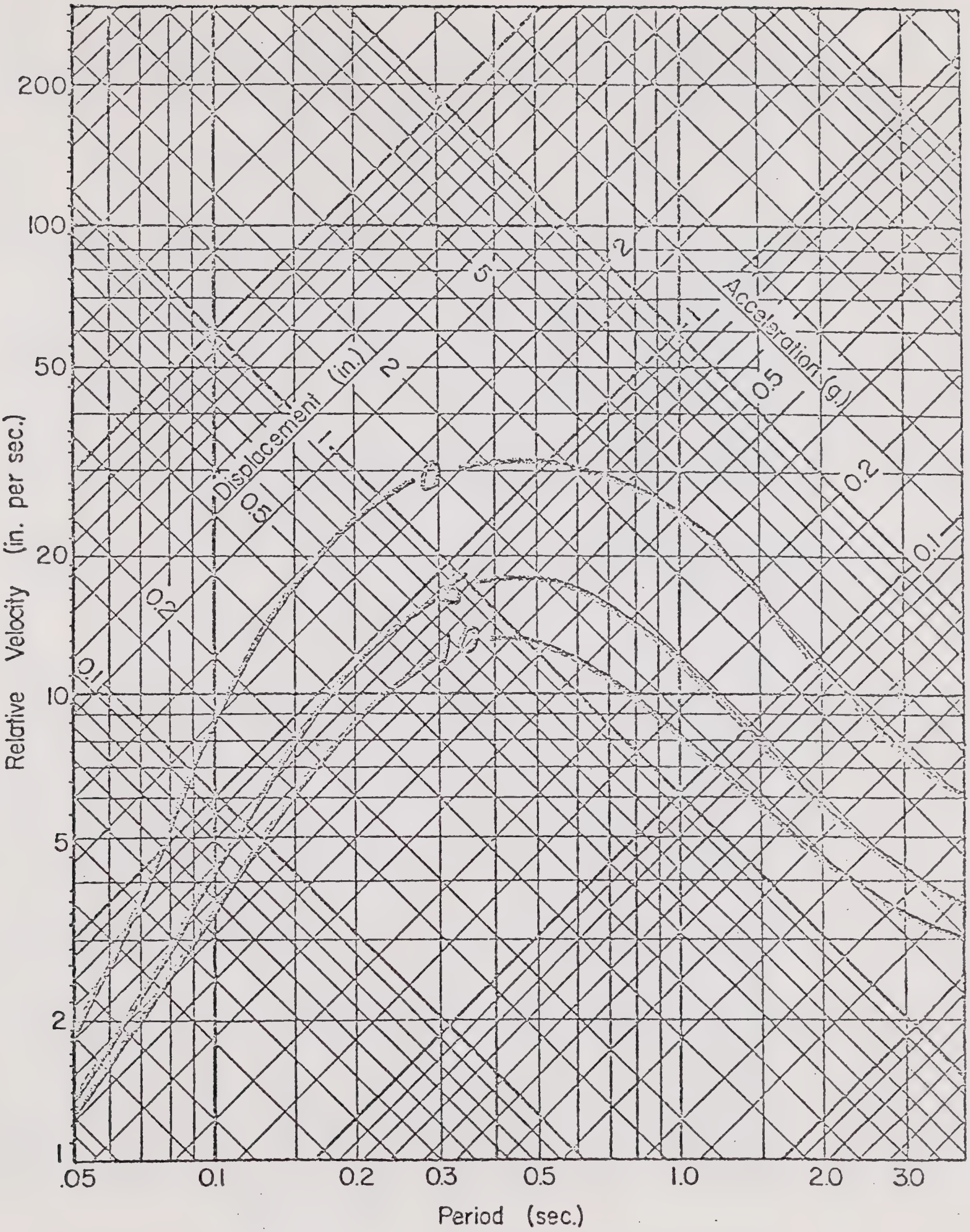



Figure 3. Response spectrum from Zone IID. Curves are for 0, 5, and 10% critical damping.

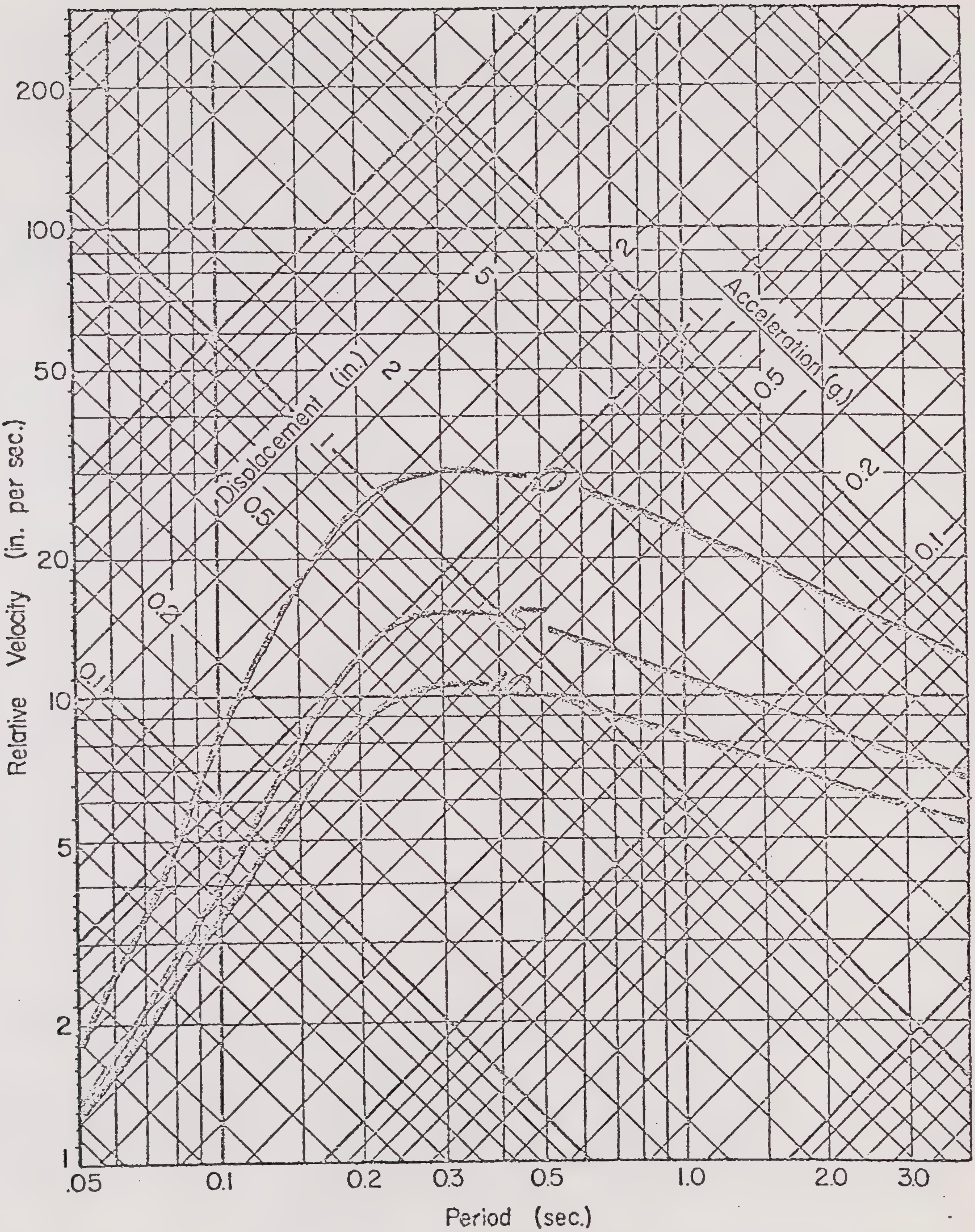



Figure 4. Response spectrum from Zone IIIA. Curves are for 0, 5, and 10% critical damping.

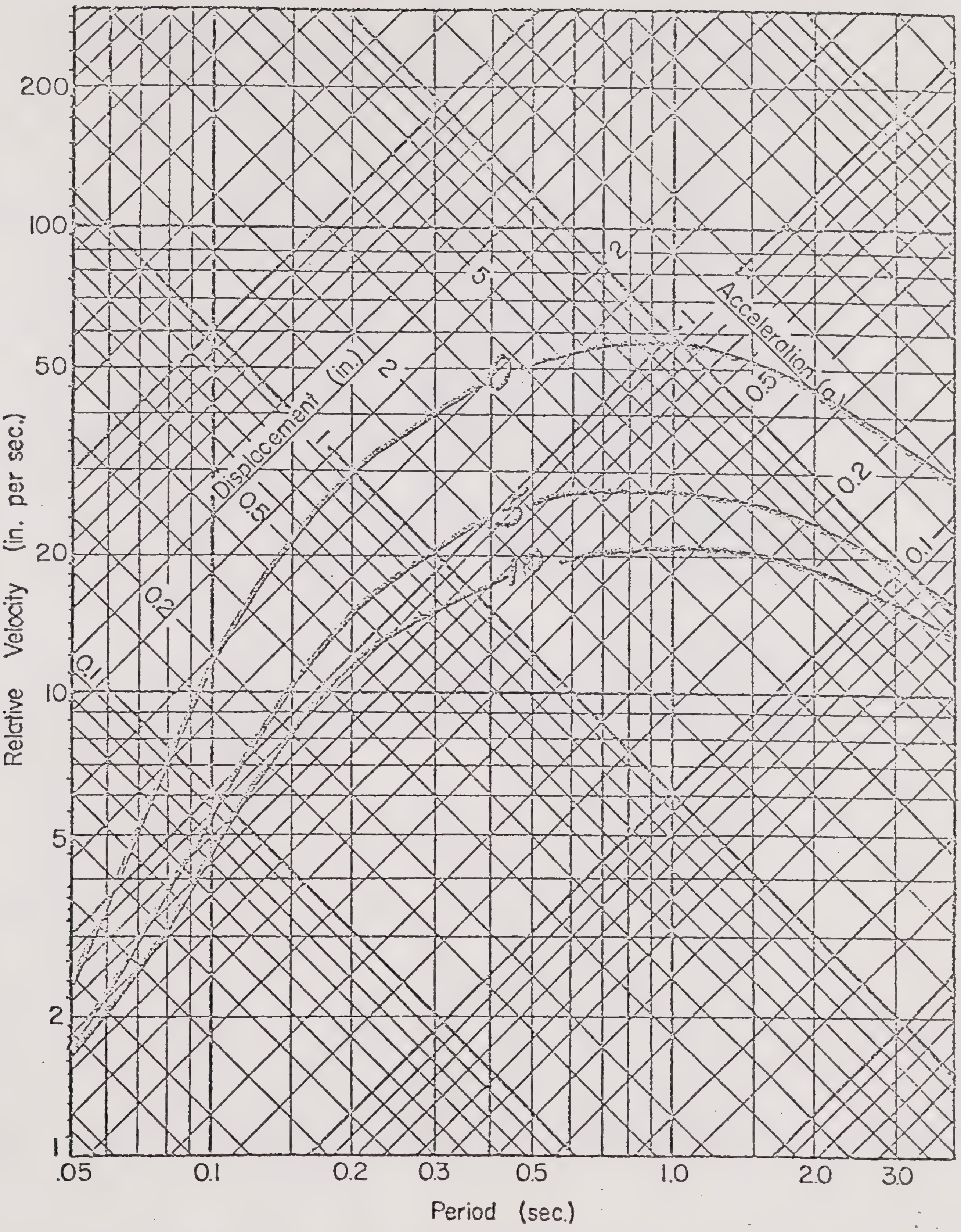



Figure 5. Response spectrum from Zone IIIB. Curves are for 0, 5, and 10% critical damping.

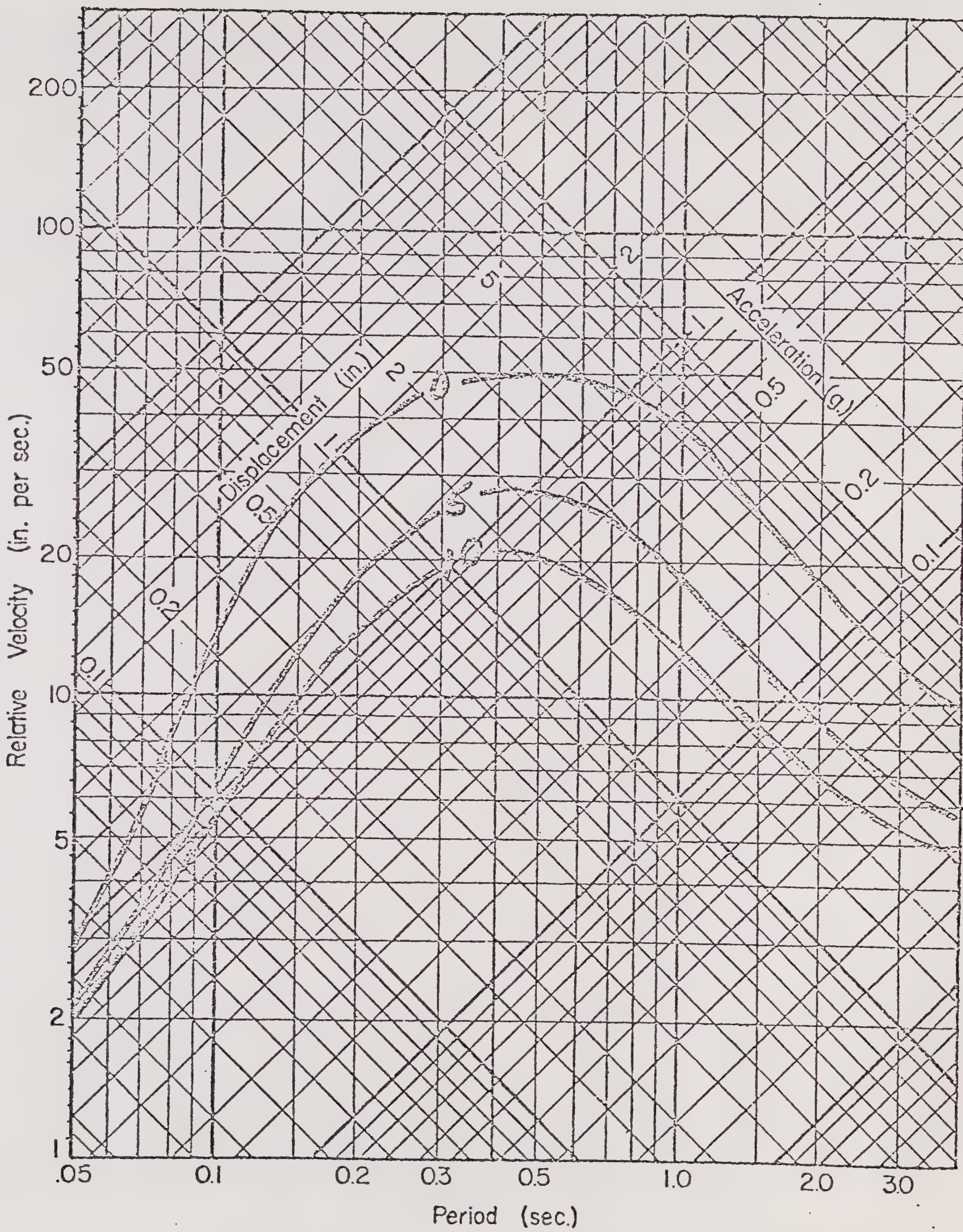



Figure 6. Response spectrum from Zone IIID. Curves are for 0, 5, and 10% critical damping.

evidence no governmental response is recommended at this time. However, the County Geologist should be alert to any new data that may help resolve this problem.

- Earthquake shaking is expected to be moderately strong as the result of movement on the nearby San Jacinto fault zone. The areal distribution of the zonation for ground shaking is shown on Plate I, and the general characteristics of the expected shaking are given in Table 1. Applicable response spectra are referenced in the Table and included as Figures 1 through 6.

- Liquefaction is not a problem in the planning area because groundwater is generally below 100 feet. Settlement, however, may be a problem in that surficial sediments are similar to those in the San Jacinto Valley to the southeast where significant settlement has been reported. No specific problem areas have been identified, but soils engineers should be alert to this potential problem in conducting foundation investigations in the area.

- Slope instability problems are moderate in relation to the County generally, and low in relation to many areas of California. However, the potential for instability exists in all hillside areas, and engineering geologic investigations are recommended for developments in these areas.

- Seiching may present a hazardous situation in water storage tanks on hillside locations above developed areas. No specific tanks have been identified as being hazardous, but tanks constructed in the future should be designed for the expected ground shaking as defined herein.

2. Flooding Hazards

Hydrologic Setting

The City of Perris is located in the broad, and very-flat Perris Valley in western Riverside County. Mean elevation is approximately 1486 feet and average seasonal rainfall is approximately 11.56 inches (Troxell, 1948). Most rainfall occurs during the months of winter and early spring, as is characteristic of Mediterranean climates.

The Perris Valley has never developed a well-defined natural watercourse. This is because of high rates of percolation in valley bottoms and the flat, shallow gradients of local topography. However, during periods of heavy rainfall, local watersheds demonstrate the lack of drainage potential in the Perris Valley.

To help facilitate better drainage during periods of high runoff, the Perris Valley Storm Drain was constructed by the Riverside County Flood Control and Water Conservation District (RCFCWCD). The channel traverses the valley in a southerly direction and receives flood runoff from the Sunnymead Channel System, Moreno Valley, and the March Field area. The channel then empties into the San Jacinto River near Highway 395.

The Perris Valley Storm Drain conveys considerable amounts of water during periods of high runoff, and at certain times, it has actually surpassed the San Jacinto River in terms of peak flow, as demonstrated in the following table.

Table 2
PEAK FLOWS & VOLUMES AT DISTRICT
OPERATED STREAM GAGING STATIONS FOR
VARIOUS STORM PERIODS

| | San Jacinto River | | Perris Valley Channel | |
|---|---|---|---|---|
| Storm Period | Peak Flow cfs. | Total Vol. (A.F.) | Peak Flow cfs. | Total Vol. (A.F.) |
| 1/152 - 2/20/52 | 1,570 | 7,070 | N.R. | N.R. |
| 3/7/58 - 4/16/58 | 478 | 7,987 | 224 | 649 |
| 11/22/65 - 12/4/65 | 460 | 1,795 | 1,760 | 1,777 |
| 12/3/66 - 12/21/66 | 369 | 1,733 | 567 | 1,206 |
| 1/19/69 - 2/17/69 | 1,570 | 6,501 | 3,590 | 3,508 |
| 2/18/69 - 5/21/69 | 5,334 | 50,039 | 6,250 | 12,526 |

NOTE:

"San Jacinto River" measured at Railroad Canyon Weir. Period of record = 1951 to 1969
"Perris Valley Channel" measured at Nuevo Road Bridge. Period of record = 1956 to 1969

Taken from "Report on 1969 Storms in Riverside County", Riverside County Flood Control and Water Conservation District.

## Hazards Potential for Flooding

### Flooding (Plate II)

Taken from: 1) RCFCWCD 1974 Flood Hazard Areas
2) Corps of Engineers (1970) Flood Plain Information Corps of Engineers

Historically the City of Perris has experienced significant flooding during heavy storm activity periods, along virtually the entire length of the Perris Valley Storm Channel. Studies by both the U.S. Corps of Engineers and Riverside County indicate the flood plain associated with channel overflow will extend to the west of the present channel an average of 2000 feet from where the channel enters the study area to San Jacinto Boulevard.

South of San Jacinto Boulevard the floodplain associated with the Perris Valley becomes more extensive as the channel nears its confluence with the San Jacinto River. Backwaters from the San Jacinto River are caused by the river's restricted passage through Railroad Canyon, and contribute to the flooding potential in the Perris area.

Although the 100-year flood plain does not effect the downtown Perris area, substantial damage to outlying residential and agricultural areas northeast of the City could occur. It is expected that a 100-year flood will interrupt traffic flow along several of the local routes, including U. S. 395 and the Atchison, Topeka and Santa Fe rail line.

Improvements are proposed that will more efficiently control flood flows along the San Jacinto River; however, no similar measures have been proposed to increase the capacity of the Perris Valley Channel. As a result, flooding in the foreseeable future will be partially mitigated toward the south end of the valley only. Potential flooding conditions north of San Jacinto Avenue will remain.

Hazards Potential for Dam Inundation

The Perris area lies within the potential inundation plain of three reservoirs: Lake Hemet Dam, Pigeon Pass Reservoir, and the Lake Perris Dam. Each of these reservoirs pose significant inundation hazards: Lake Hemet Dam because of its 14,000 acre foot capacity, and Pigeon Pass Reservoir because of its location and proximity to the north of the City. The Lake Perris Reservoir lies approximately 4 $\frac{1}{2}$ miles northeast of the central urbanized portion of Perris, and a substantial portion of the area within the City limits would be subject to inundation on short notice should a catastrophic failure of this facility occur.

Lake Hemet Dam

Lake Hemet Dam is an earth-fill facility located upstream of the Perris area on the San Jacinto River. A complete failure of the dam at full capacity would cause major flooding throughout the San Jacinto River Valley. Especially hard-hit would be areas adjacent to the City of San Jacinto where flooding greater than the Corps of Engineers "standard project flood" would occur.

The initial flood wave from Lake Hemet would require approximately 7 $\frac{1}{2}$ hours to reach the Perris area. Resulting inundation would be largely restricted to an area south of Metz Road, and would approximate in severity the 100-year flood. The amount of time required for the flood wave to reach the City area would mitigate much of the hazard to public safety; however, extensive property damage in the inundated areas would still be anticipated.

Pigeon Pass Reservoir

Pigeon Pass Reservoir contains at full capacity approximately 912 acre feet of water, and is impounded by an earth-fill dam. It is located north of the Perris area, at the mouth of Pigeon Pass Canyon and serves as a flood-control facility for that watershed. As such, the reservoir is usually without water.

A failure of Pigeon Pass Dam at full capacity would inundate an area approximately $\frac{1}{2}$ - 1 mile wide, roughly paralleling the Perris Valley Storm Drain. The initial flood wave would reach the City in approximately 225 minutes, and traverse the area in an additional 450 minutes. The entire flooding episode would be brief, and would be generally less extensive than a 100-year flood along the Perris Valley Storm Drain.

## Lake Perris Reservoir

As the southernmost terminus of the California State Water Project, Lake Perris is an important water storage facility for Southern California. The lake also serves as a major recreational attraction for this region of the state as it is developed as a State Park providing boating, camping, hiking and other facilities. Lake Perris covers a total area of 2,240 acres and has a maximum capacity of 120,000 acre feet of water. The dam itself, which is of rock and earth fill construction, is 126 feet high and is more than two miles long. While this structure is designed to withstand the effects of the maximum probable earthquake expected to occur within the area, a partial or total failure of this dam would inundate large areas of the City and its environs in a very short time period. In the event of total failure, the intersection of Perris Boulevard and Nuevo Road would be inundated within 20 minutes, according to the maps published by the State Department of Water Resources. Most of the area south of Oleander Avenue and east of Highway 15-E north of this point would be covered with water, as would the area east of Perris Boulevard along the urbanized portion of the City. Waters would backflow north along the San Jacinto Fiver flood-plain, and the inundation could continue southwest as far as Railroad Canyon and along Ethanac Road in the direction of Romoland and Sun City. It is important to note that although such an event is very unlikely, all of the evacuation routes to the north, east and southeast of the City could become impassible should such a catastrophic dam failure occur.

While dam failures and subsequent inundations are events that are considered very unlikely to occur, the nature of this hazard and its possible widespread catastrophic effects should be considered in the City's safety and disaster response planning. The inundation maps for Perris Dam, which are available for review in the Planning Department and the Riverside County Office of Disaster Preparedness, should be incorporated by reference into this Safety Element as well as the Comprehensive Perris General Plan. Plate VII B (Safety Element Map), which is included in this Element, shows the inundation areas for both Lake Hemet Dam and Pigeon Pass Reservoir, as well as the generalized areas subject to 100 year interval flooding.

Dam failures and subsequent inundations should be considered as events that can occur, but are very unlikely to occur. However, the nature of the hazard is such that it should be considered.

## Conclusions

- The City of Perris and environs are exposed to substantial 100-year flooding risks, originating along the Perris Valley Storm Drain and the San Jacinto River. Flooding at the 100-year level will not impact the urbanized portions of downtown Perris, although damages can be expected to occur in areas along the Perris Valley Channel. Local transportation will be interrupted as would Route 15-E, the major traffic link in the areas.

- The area would be impacted in the event of a failure of Lake Perris Dam, Lake Hemet Dam or Pigeon Pass Dam. While the areas subject to inundation after failure of either the Lake Hemet or Pigeon Pass Dam would generally follow the 100 year flood plain areas along the Perris Valley Storm Channel and San Jacinto River, a failure of

Lake Perris Dam would affect a significantly larger area of the City and the surrounding areas of Perris Valley. A failure of the Hemet Dam would have a greater effect upon the region than would a similar event involving the Pigeon Pass Dam; however, because of its proximity, Pigeon Pass Dam presents a more substantial potential hazard to the Perris Valley Area.

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In view of the nature of these dam failure and resultant inundation hazards, the City should develop an adequate emergency evacuation plan as part of its overall disaster response planning. This evacuation plan should be integrated with the City of Perris Emergency Operations Plan as it is periodically updated and revised, and it should satisfy the applicable requirements of State Law. (Government Code Section 8589.5)

3. Fire Hazards

General Information

The City of Perris Fire Department was formed in 1911 as a process of incorporation. The department is a volunteer force under the direction of one full-time paid Fire Chief along with a staff of one Fire Prevention Officer and one Clerk/Dispatcher - who are also full-time and paid by the city. The department has provided continuous service since its founding and was the first in western Riverside County to provide a resuscitation service as a portion of its rescue operations.

The city maintains two mutual aid agreements for fire service. One is the State of California Mutual Fire Aid Agreement, and the other is with the State Department of Forestry/Riverside County Fire Department. Under terms of the agreements, the city department can request additional support of either men or equipment.

Presently, the department has three (3) fire and rescue vehicles which cover the city service area:

1) a Van Pelt 1000 GPM pumper
2) a Crown 1000 GPM pumper
3) a GMC rescue-equipped van

Being considered for purchase to replace the GMC rescue-equipped van is a quick-attack vehicle which has a combination of emergency rescue and firefighting capabilities. This replacement will considerably lessen the operational cost on incidents where both rescuing and firefighting may be necessary - i.e., vehicle traffic collisions and/or vehicle fires.

Communications equipment consists of the following:

A. Three (3) Motorola Mocom-70 Transceivers on the fire vehicles.
   1. Operating Frequencies
      a. 153.770 MHZ, Perris City Fire Net
      b. 154.145 MHZ, County Fire Net 1
      c. 154.230 MHZ, State Fire Net 1

B. One (1) 100-Watt Base Station
   1. Consoles - 24-hour coverage
      a. Fire Department Dispatch
      b. Police Department Dispatch

The Volunteers possess ten (10) alert monitors for fire notification and have these issued to key members for home use. The Fire Chief utilizes a Handy-Talkee for control communications at fires.

All department members undergo rigid training ranging from the procedural handling of structural, brush and wildland fires to the proper use and maintenance of equipment and are certified. Ongoing training in first aid for injury and CPR is also provided and certification required. A level of state certification of Fire Fighter I is the department goal for all volunteers.

The department maintains a close coordination with the Police, Public Works, and Building & Safety Departments on a daily basis. Constant energies are being expended by Fire, Planning, and Public Works Department personnel to upgrade fire flow capabilities and protection criteria in new and rehabilitable structures.

The present location of the department, within the Civic Center, sufficiently meets response criteria to the urbanized area. However, the long term growth and urbanization reflected in the general plan indicates the present departmental system and location may become unsatisfactory. More men, equipment, and other station locations will be necessary should growth projections prove accurate. A comprehensive plan for the future development of the department and its needs is being considered.

## Fire Hazard Discussion

The fire service area of the city is in transition from predominantly rural to urban in nature. The city presently covers 13.5 square miles of which approximately 3 square miles is urbanized and of which 70% of the urbanized area is centralized. This is graphically portrayed by the city map shown in Figure 8.

As would be expected by such service area statistics, the main fire threat and most responses involve brush/wildland fires. However, the percentages of fire experiences as reported by the department indicates a consistent shift in fire types from vegetation to urban-related types.

As shown on tables F1, F2 and F3, a progressive trend to increased structural fire incidents is indicated. Industrial, commercial, and residential structures will soon become the primary fire hazards in the developed core area of the city.

The map shown in Figure 9 shows the fire zones assigned to the city plus the Public Works Department water lines. Under Council approval an upgrading program of fire flow service lines under the Public Works Department direction and placement of additional hydrants has been instituted.

FIRE EXPERIENCE TABLE I
FROM 1975 STATISTICS

| TYPE | | PERCENTAGE |
|---|---|---|
| 1. Unknown | | 0% |
| 2. Buildings | | 16.5% |
| a. Institution | 1.3% | |
| b. 1-2 Family Residence | 7.5% | |
| c. Multiple Family Residence | 1.3% | |
| d. Storage Building | 1.4% | |
| e. Special Structure | 3.7% | |
| f. Unoccupied - Construction | 1.3% | |
| 3. Grass | | 63.2% |
| 4. Vehicle | | 5.0% |
| 5. Refuse | | 11.4% |
| 6. Outside Structure | | 1.3% |
| 7. Explosion | | 0% |
| 8. Mobile Home | | 0% |
| 9. Other | | 2.5% |
| TOTAL | | 100.0% |

FIRE EXPERIENCE TABLE II
JANUARY 1, 1980 - DECEMBER 31, 1980

| TYPE | | PERCENTAGE |
|---|---|---|
| 1. Unknown | | 1.7% |
| 2. Buildings | | 20.5% |
| a. Institution | 4.7% | |
| b. 1-2 Family Residence | 8.1% | |
| c. Multiple Family Residence | 1.3% | |
| d. Storage Building | 1.3% | |
| e. Special Structure | 5.1% | |
| f. Unoccupied - Construction | 0% | |
| 3. Grass | | 47.4% |
| 4. Vehicle | | 13.7% |
| 5. Refuse | | 5.1% |
| 6. Outside Structure | | 2.6% |
| 7. Explosion | | 1.3% |
| 8. Mobile Home | | 3.0% |
| 9. Other | | 4.7% |
| TOTAL | | 100.0% |

FIRE EXPERIENCE TABLE III
JANUARY 1, 1981 - NOVEMBER 18, 1981

| TYPE | | | PERCENTAGE |
|---|---|---|---|
| 1. | Unknown | | .9% |
| 2. | Buildings | | 29.6% |
| | a. Institution | 5.1% | |
| | b. 1-2 Family Residence | 7.3% | |
| | c. Multiple Family Residence | 1.8% | |
| | d. Storage Building | 1.3% | |
| | e. Special Structure | 14.1% | |
| | f. Unoccupied - Construction | 0% | |
| 3. | Grass | | 36.4% |
| 4. | Vehicle | | 10.7% |
| 5. | Refuse | | 9.9% |
| 6. | Outside Structure | | .4% |
| 7. | Explosion | | .9% |
| 8. | Mobile Home | | 5.6% |
| 9. | Other | | 5.6% |
| | TOTAL | | 100.0% |

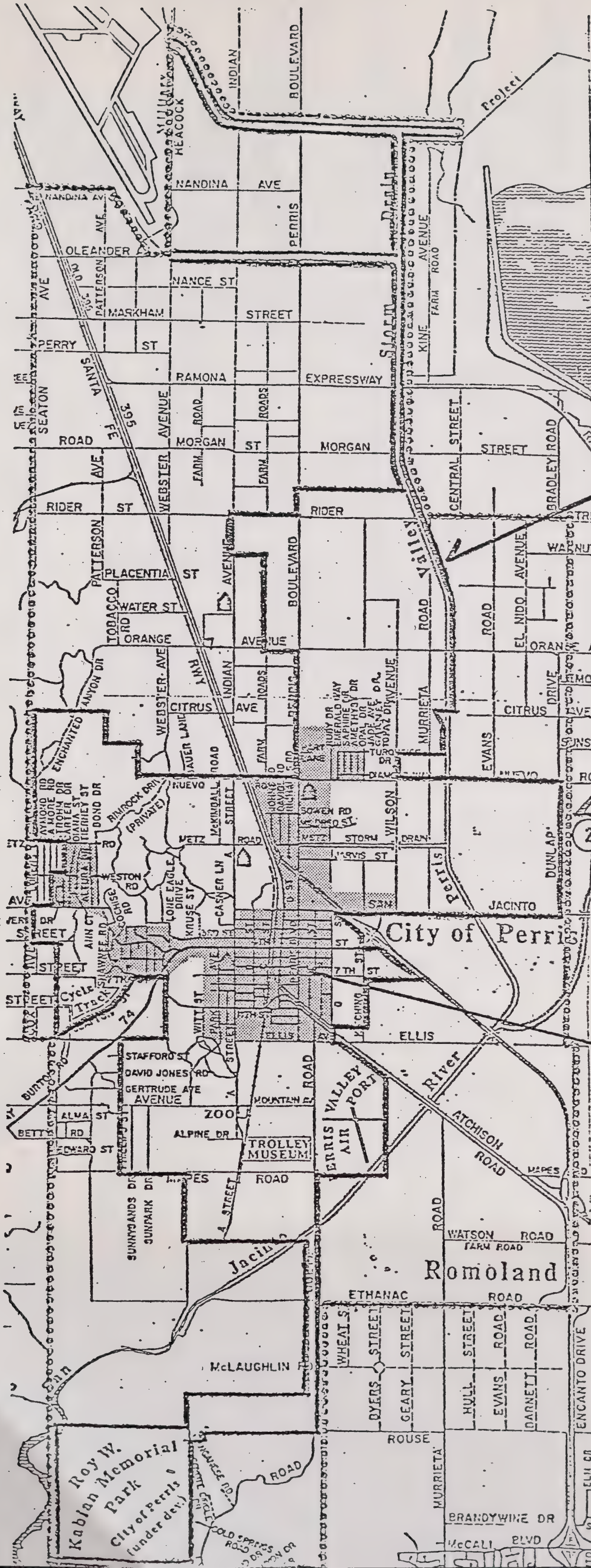


Figure 8

① City Boundary

② Sphere Boundary

③ Urbanized Area

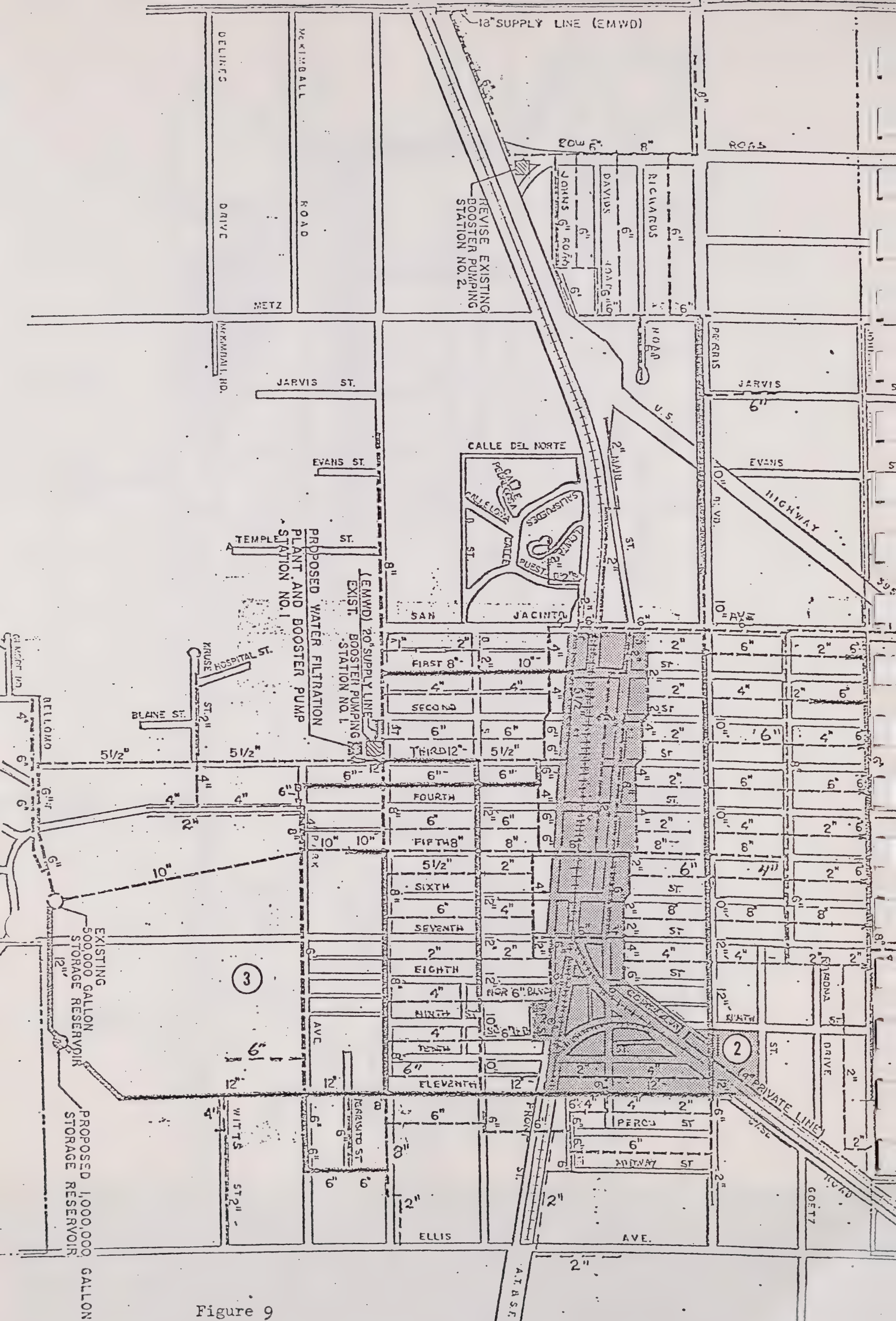


Figure 9

(1) Fire Zone 1 - Not Assigned

(2) Fire Zone II

(3) Fire Zone III - all city areas not in II

C. Risk

The Council on Intergovernmental Relations (CIR) defines "Risk" from natural and man-made hazards in three categories:

1. Acceptable Risk: The level of risk below which no specific action by government is deemed to be necessary.

2. Unacceptable Risk: The level of risk above which specific action by government is deemed to be necessary to protect life and property.

3. Avoidable Risk: A risk which need not be taken because individual or public goals can be achieved at the same, or less, total "cost" by other means without taking the risk.

Determining levels of appropriate or acceptable risk is a multi-disciplinary process which relies heavily on citizen input. There is no such thing as a perfectly hazard-free environment. Natural and man-made hazards of some kind are always present, especially in urban areas. However, effective loss-reduction measures can be used in mitigating the consequences of known hazards. The determination of acceptable risk involves making a judgment about risk, either explicit or implicit, which is a necessary step in planning for loss-reduction from natural hazards.

The central concept used in determining acceptable risk is the definition of natural events in terms of magnitude and frequency. The magnitude of an event refers to its size. Examples are the height of flood waters, the rating of an earthquake on the Richter scale, or the number of acres burned in a wildland fire. The frequency of an event refers to the number of times it occurs during a certain period of time. That is, the less often an event occurs, the greater is its size and potential impact. For example, rainstorms occur annually in the City of Perris, but most often they are of low magnitude and do not seriously threaten the City. However, on relatively infrequent occasions, as in December of 1964, a storm of great magnitude will pass over the City and result in destructive flooding. A way of summarizing this concept with respect to an earthquake is that the longer it waits, the bigger it will be.[1]

The magnitude-frequency concept is involved in the decisions regarding acceptable risk in that the community must judge what magnitude event should be planned for. The judgment is based on the frequency or recurrence interval of the hazardous event. A description of the magnitude and other characteristics of the event are then developed through a technical analysis. This information allows planners and engineers to develop loss-reduction measures and to design structures to provide protection up to the level of acceptable risk. In this sense, the magnitude earthquake or flood used in defining acceptable risk may be thought of as a "design earthquake" or "design flood."

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[1]There is one important difference between flooding and earthquakes, however, flooding is the result of a random combination of meteorological events, whereas current geologic theory indicates that the buildup of strain along a particular fault system is nearly constant and the periodic release of that strain in the form of an earthquake is apt to be regular.

| Land Use Group | Facility Type | Facility | Appropriate Recurrence Interval (Years) | Magnitude by fault San Jacinto |
|---|---|---|---|---|
| A | Emergency Services | Hospitals, Fire Stations, Police Stations, CO HQ, Lifeline - Gas Electric, Water, Ambulance Services, Emergency Broadcast Systems, Lifeline Telephone Systems, Power Plants (Nuclear, Fossil Fuel), Dams, Reservoirs. | Maximum Credible | 7.5* |
| B | Critical Facilities | Schools, Theaters, Auditoriums, Utility Substations, Sewage Treatment Plants, Waterworks, Local Gas and Electric Lines, Major Highways, Bridges, Tunnels, Aqueducts, Pipelines, Public Service Facilities, Public Assembly w/ Capacity of 100 or more. | 200-500 | 7.0* |
| C | Normal Facilities | | | |
| | Category 1 | Heavy Industrial, Office Buildings, Commercial Centers, Hotels and Motels, Parks and Financial Establishments, High Density Residential, Public Service Stations, Health Care Clinics. | 100-200 | 6.5* |
| D | Category 2 | Light Industrial, Low Density, Residential, Warehousing and Storage, Agricultural, Parks, Convenience Centers. | 50-100 | 6.0 |

(* Ground Rupture Expected)

The determination of acceptable risk from hazardous events also involves differentiating among man-made structures according to their potential effect on the loss of life and their importance in terms of continued community functioning. In the hours immediately following the 1971 San Fernando earthquake in Southern California, emergency services were impaired by damage to police and fire stations, communication networks, and utility lines. Several hospitals were seriously damaged and unable to continue functioning. These facilities and others are vital to the community's ability to respond to a major disaster and to minimize loss of life and property. The experience in San Fernando emphasized the need to provide these "critical facilities" a higher level of protection from earthquakes than limited or normal occupancy structures or other non-critical structures. As a minimum, all structures which could have an effect on the loss of life should be designed to remain standing in the event of a major earthquake even if rendered useless. Critical facilities on the other hand, should not only remain standing, but should be able to operate at peak efficiency in the event of a disaster. The taxonomy of Critical Facilities presented is intended for use as a guide in evaluating the importance of each facility relative to overall public safety, in terms of fire, inundation, and seismic hazards.

Based on the discussion above and on input from representatives from the City of Perris, the following seismic events are recommended as the basis for establishing earthquake design standards:

TAXONOMY OF CRITICAL FACILITIES

| Land Use/Facility | Safety Characteristic | | | Classification | |
|---|---|---|---|---|---|
| | Potential Effect on Loss of Life | Emergency Response | Vital Function | Critical | Normal |
| Developed Land | | | | | |
| RESIDENTIAL | | | | | |
| Single Family | | | | | X |
| Multi-family and Mobile Homes | | | | | X |
| Apartments | | | | | X |
| COMMERCIAL | | | | | |
| Neighborhood Centers (e.g., grocery, barber, drug store) | | | | | X |
| Community Centers (e.g., private offices, banks, restaurants, comparison shopping | | | | | X |
| Highway Centers (e.g., motels, fast food, restaurants) | | | | | X |
| Heavy Commercial/ Light Industry (e.g., contractors yards, distribution warehouses, manufacturing and assembly plants) | | | | | X |
| Heavy Industry | | | | | X |
| PUBLIC AND SEMI-PUBLIC USES | | | | | |
| Hospitals | | X | X | X | |
| Schools/Colleges | X | | | X | |
| Parks and Recreation Areas | | | | | X |
| Government Facilities (e.g., civil defense quarters, fire and police stations, government offices | | X | X | X | |

TAXONOMY OF CRITICAL FACILITIES
(continued)

| Land Use/Facility | Safety Characteristic | | | Classification | |
|---|---|---|---|---|---|
| | Potential Effect on Loss of Life | Emergency Response | Vital Function | Critical | Normal |
| Developed Land | | | | | |
| PUBLIC AND SEMI-PUBLIC USES (continued) | | | | | |
| Utilities (e.g., power plants (nuclear fossil fuel) gas and electric lines and stations, large dams, radio/TV/microwave centers and lines, aqueducts, pipelines, sewage treatment facilities, gas stations, waterworks | | X | X | X | |
| Roads and Highways | | X | X | X | |
| Railroads | | | X | X | |
| Airports | | | X | X | |
| Assembly Halls (e.g., theaters, auditoriums) | X | | | X | |
| Refuse Disposal Sites | | | | | X |
| Cemeteries | | | | | X |
| Undeveloped Land | | | | | |
| Agriculture | | | | | X |

With respect to flood hazards, the magnitude event recommended as the basis for natural flood control and floodplain planning and management is the 100-year flood. The 100-year flood is almost universally accepted by federal and state agencies involved with flood control as the basis for describing flood hazards and establishing flood insurance and other programs. Sufficient data is not available at this time to recommend specific flood parameters for planning purposes relative to dam inundation except for evacuation purposes.

## III. HAZARD REDUCTION

### A. Organization And Purpose of Recommendations

The previous section of this document represents a synthesis of the existing natural hazards within the study area, and supplements the criteria documented in the Technical Section of the report. The intent of that section is to summarize the general framework within which planning for seismic safety and public safety should take place. In this section, recommendations are presented which encompass the general planning goals and policies for hazard reduction in the City of Perris. This section also outlines specific recommended planning actions to implement the Element's Goals and Policies.

### B. General Goals

To plan effectively for reducing hazards to acceptable levels of risk it is necessary that goals be set and adhered to. Goals address general policy directions which form the basis for planning decisions and actions. The recommended goals for hazard reduction in the City of Perris are:

1. Create and preserve the best possible living environment for all inhabitants;

2. Attain a safe, healthy and stable living environment;

3. Manage development in order to reasonably protect inhabitants from natural hazards;

4. Educate and inform inhabitants of naturally induced and human induced safety hazards and means to mitigate or prevent loss of property and life;

5. To minimize social and economic dislocations resulting from injury, loss of life, and property damage caused by hazardous natural events.

### C. Specific Goals

1. Fire

    a. Manage development in order to reasonably protect inhabitants from fire hazards;

    b. Educate and inform inhabitants of fire hazards and means to mitigate or prevent loss of life or property;

    c. Provide continued service capability based upon needs created by growth or changes in use requirements;

    d. Upgrade fire protection service rating of the community;

    e. Prevent destruction of natural and historical resources of the community.

2. Flood

   a. Manage development in order to reasonably protect inhabitants from flood hazards;

   b. Eliminate flood hazard through long range flood control measures;

   c. Reduce flood impact through immediate short term flood control measures;

   d. Prevent loss of life and reduce property damage and losses as a result of flooding.

3. Dam Inundation

   a. Prevent loss of life and minimize damage resultant from inundation;

   b. Eliminate inundation hazards through engineering and construction.

D. General Policies

The following recommended policies complement the planning goals and define specific directions for the City to take in reducing natural hazards.

1. Provide for continued research and analysis of hazards affecting the community;

2. Perform continued evaluation and recommend changes in ordinances as necessary to improve safety;

3. Impose reasonable safety-oriented restrictions upon land use and zoning actions to insure hazards have been considered prior to development;

4. Recommend construction improvements to existing and programmed structures to insure that unacceptable risk is minimized or eliminated;

5. Provide for critical facilities and their retention in case of natural disaster;

6. Formulate plans and programs to provide guidance and response principles necessary to support fire, flood, seismic and dam inundation hazards control and mitigation, and insure their continued review and updating.

E. Specific Policies

1. Fire

   a. Provide continued coordination with federal, state, county and other community agencies in research and analysis of fire safety concerns;

   b. Evaluate and recommend changes in procedures to improve fire safety;

c. Impose reasonable safety requirements upon development, repair or rehabilitation projects to insure fire safety conditions are considered;

d. Formulate plans and programs to provide for fire prevention, protection and disaster responses;

e. Adopt measures to provide adequate structural fire protection for residences which are constructed in outlying areas that are subject to vegetation fire hazards.

2. Flood

a. Perform continued research and analysis of flood hazards;

b. Prepare flood studies and plans designed to eliminate flood hazard;

c. Impose restrictions upon land use and zoning actions to insure flood concerns have been considered prior to development;

d. Continue participation under National Flood Protection Act to insure availability of insurance to land owners and developers affected by the flood hazard area.

3. Dam Inundation

a. Require continued study and evaluation of inundation hazards;

b. Cooperate in continued planning actions to minimize dam inundation;

c. Incorporate an adequate plan for evacuation in the event of dam inundation in the City's disaster preparedness program and activities; provide for periodic review and update of this plan.

4. Seismic

a. Adopt new ordinances and amend existing ordinances which require the incorporation of seismic safety and safety considerations in developments under the City's jurisdiction;

b. Provide for the identification and evaluation of existing structural hazards;

c. Risks associated with hazardous structures should be reduced to acceptable levels through orderly hazard reduction.

d. Provide for more detailed scientific analyses of seismic hazards in the study area;

e. Regulate land use in areas of significant seismic hazard.

F. Implementation Measures

General:

a. Adopt new ordinances and amend existing ordinances which require the incorporation of seismic safety and safety consideration in developments under the City's jurisdiction;

b. Adopt the most recent edition of the Uniform Building Code as revisions are periodically made.

c. Provide for the identification and evaluation of existing structural hazards;

d. Risks associated with hazardous structures should be reduced to acceptable levels through orderly hazard reduction programs;

e. A review committee should be established by the City Council to consider the desirability of initiating condemnation proceedings against structures found to be unsafe;

f. The City should advocate the expansion of State and Federal relocation assistance funds and programs to aid persons and businesses displaced from hazardous buildings;

g. Provide for more detailed scientific analyses of natural hazards in the study area;

h. Regulate land use in areas of significant natural hazard;

i. Provide for the education of the community regarding the nature and extent of natural hazards in the study area;

j. Develop an information release program to familiarize the citizens of region with the Seismic Safety and Safety Elements. Special attention should be afforded to those groups particularly susceptible to seismic, fire, and flooding hazards including, but not limited to, school districts, agencies involved with the aged, and agencies involved with handicapped persons. These agencies should be encouraged to develop educational programs of their own relative to hazard awareness. The conclusions and recommendations of these elements should also be provided to land developers and those involved in the real estate profession. Appendix A provides a list of earthquake safety procedures;

k. Establish community programs that train volunteers to assist police, fire, and civil defense personnel during and after a major earthquake, fire or flood;

l. Initiate education programs in lower grades using displays and demonstrations that would expose younger children to the nature and strength of fire. Such programs would tend to replace their natural curiosity with a sense of respect;

m. Support or sponsor exhibits and presentations in secondary schools which demonstrate the more involved aspects of fire dynamics, i.e., major contributing factors to fire hazard and the relationship of fire to the natural ecology. Encourage parental cooperation and assistance in overall fire education programs;

n. Provide for the maintenance and upgrading of disaster response plans;

o. Maintain a disaster response program for the City of Perris. Objections of the program should be:

   1. To save lives and protect property;

   2. To provide a basis for direction and control of emergency operations;

   3. To provide for the continuity of government;

   4. To repair and restore essential systems and services (e.g., emergency water supplies);

   5. To provide for the protection, use and distribution of remaining resources;

   6. To coordinate operations with the civil defense emergency operations or other jurisdictions;

   7. To provide for a maximum degree of self-sufficiency by the City in the event of a major disaster.

   Since a large earthquake will severely affect many cities and hundreds of thousands of people, the efforts of the Federal and State emergency services will be severely overextended. It is advisable that the City be prepared to serve itself and maintain continued functioning of necessary services rather than expect adequate aid from outside organizations;

p. Conduct periodic earthquake, and flooding emergency drills. These drills should be coordinated on a regional basis in cooperation with all involved jurisdictions;

q. Provide for review and upgrading of the Seismic Safety and Safety Elements;

r. Upon adoption of the Seismic Safety and Safety Elements, a review committee should be established to oversee the implementation of the Elements and to advise the Council of implementation progress. This committee should be composed of the Planning Director, the Director of Building and Safety, and at least one representative from each of the police and fire protection service agencies;

s. The Seismic Safety and Safety Elements should be reviewed by the City Planning Department annually and should be comprehensively revised every five years or whenever substantially new scientific evidence becomes available.

Specific:

1. Seismic

   a. Using the geological data provided in the Seismic Safety Element, amend Chapter 23, Section 2314, (Earthquake Regulations) of the Uniform Building Code to account for the expected maximum ground accelerations of the recommended design earthquakes. Amending Section 2314 involves revising the basic lateral force equation in the section, and requires analysis by a qualified structural engineer. The intent of the revisions is to reflect the levels of acceptable risk adopted in this Element. (At this time, proposed revisions to Section 2314 are being considered by the International Conference of Building Officials for adoption in the 1976 UBC. The proposed revisions would significantly increase the minimum lateral force requirements, and could, if adopted, reduce the extent of revision necessary to amend the code in conformance with expected seismic events.)

   b. Amend Chapter 70, Section 7006, of the Uniform Building Code to require soils engineering and geological engineering investigations in areas of moderate and high landslide risk and in potential liquefaction and subsidence areas. To insure adequate review and use of the investigation reports, the City should retain a qualified engineering geologist on a full or part-time basis to review the reports and assist the Building and Safety Department in designing public projects;

   c. It is recommended that structures within the study area of this report be inspected for conformance with the amended Uniform Building Code earthquake regulations. Inspections should be conducted according to the following priorities:

      1. Emergency service facilities (e.g., fire and police stations, hospitals);

      2. Other critical facilities (e.g., schools, utility lines, government buildings);

3. High occupancy non-critical facilities (e.g., dormitories, apartments);

4. Normal or limited occupancy non-critical facilities (offices, low density residential buildings).

Within each priority group, it is recommended that facilities built before 1933 be inspected first, then those built between 1933 and 1948, and lastly, those constructed after 1948. The significance of the year 1933 is that the Field and Riley Acts became law in California that year and required reinforcement in schools and certain other structures (Appendix B). Structures built before 1933, especially larger commercial structures, are more likely to be unreinforced masonry block buildings which are most susceptible to collapse in earthquakes. In 1948, earthquake regulations were adopted as a legally binding section of the UBC for the first time. Previously, earthquake standards were not a mandated part of the Code. It is more likely, then, that a building constructed before 1948 would be less able to withstand the shock of an earthquake than one built after 1948. It is also recommended that public structures be inspected before private structures.

Table 3(abridged from Pacific Fire Rating Bureau) may also be used as a general indicator in older construction for use in establishing a priority ranking system for evaluating structures. Buildings with a high susceptibility to damage rating (five or over) should be selected for structural inspection before those with low ratings. A high priority should be placed on establishing a definition of facilities that handle explosive, flammable, or toxic materials and on an evaluation of their seismic vulnerability.

d. Caltrans should review its facilities and roadways within the study area to determine the potential impact of expected earthquakes, and should forward comments to the City. The Circulation Element of the General Plan and potential evacuation routes should be revised, if necessary;

e. The Atchison, Topeka & Santa Fe Railway Company should review its lines and yards within the study area to determine the potential impact of the expected earthquakes, and should forward comments to the City. The Circulation Element of the General Plan should be revised, if necessary;

f. The owners of any existing dams in the Perris Valley area should inspect their dams using the seismic response spectra as guidelines to determine these structure's ability to withstand expected earthquakes, and should forward comments to the City;

g. The Southern California Gas Company and the Edison Company should review their facilities and distribution/transformation networks and centers to determine the potential impact

of expected earthquakes, and should forward comments to the city. These utilities should also review their gas and power lines for potential fire hazards in the event of an earthquakes;

h. Structures identified as not conforming to amended earthquake standards or as hazardous in terms of fire or flooding should be brought into conformance with acceptable levels of risk by programs including, but not limited to, structural rehabilitation, occupancy reduction and demolition and reconstruction;

i. Encourage geologic study of the potential fault (Plate I) located approximately one-half mile from Highway 395. Such appropriate geologic study should be undertaken at the EIR stage for any development proposed on or along side the suspected fault trace;

j. Require site-by-site soils and geologic engineering studies for proposed development projects in areas of moderate to high landslide risk to assess natural and graded slope stability. Slope stability calculations should incorporate the ground shaking parameters presented in the Technical Report;

k. Require site-by-site soils and geologic engineering studies in area of potential settlement and evaluate these potential hazards using the ground shaking parameters presented in the Technical Report;

l. Institute a building strong-motion instrumentation program for buildings over four (4) stories in height, if such buildings are anticipated;

m. No development should be permitted in any seismic zone unless it conforms to the recommended revised Uniform Building Code Earthquake Regulations;

n. No development should be permitted in areas of high or moderate landslide risk without a required slope stability investigation at the site level.

2. Flood

a. Encourage completion of the flood control studies and projects that would serve to mitigate flood problems;

b. No emergency facilities should be permitted to locate within the 100-year flood plain. Critical facilities should be permitted in the 100-year flood plain only if adequate flood control measures are provided;

c. Require flood control district assessment reports on all land divisions, improvements and developments lying within or suspected to be within potential flood prone areas;

d. Maintain Master Flood Control Plan and continually recommend changes or addition comensurate to growth and identified hazards;

e. Require strict enforcement of building requirements in flood prone areas;

f. Limit development in flood zones to low density residential, industrial, and commercial uses on acreages of limited size;

g. Include flood disaster response actions under the city general disaster plan.

3. Fire

a. No emergency or critical facility should be permitted to locate in high or medium fire hazard areas without an investigation of the development's vulnerability to fire and its potential as a source of ignition;

b. The use of untreated shake roofs in areas of high fire hazard should be prohibited; utilize the policies and development criteria of the Comprehensive General Plan relating to fire protection in outlying areas susceptible to vegetation fire hazards in the review of all new development proposals;

c. Adopt Uniform Fire Code and Uniform Fire Standards as Municipal Fire Code and Standards;

d. Update as necessary existing ordinances, resolutions and agreements pertaining to fire protection;

e. Provide fire department structural, communications and equipment acquisition and upgrade through capital improvements program inclusion;

f. Prepare fire plan which provides for increased manpower, geographic and demographic location of additional stations and equipment commensurate with community development and growth;

g. Perform feasibility study of a combined Public Safety Department;

h. Require fire inspections, on regular basis, of schools, public assembly buildings, civic buildings, hospitals, rest homes and homes for special occupants;

i. Include fire disaster response actions under the City General Disaster Plan;

j. Require new facilities to incorporate adequate fire protection systems as a portion of their plans; require existing special occupancies such as, commercial, industrial, schools, hospitals, and care centers to upgrade fire protection systems;

k. Require fire department review of development plans as part of the site plan review process administered by City departments; institute necessary departmental fee schedule to reimburse the cost of such review.

l. Require developers to provide for adequate fire flows through installation of adequate water service lines in developments;

m. Perform upgrade of city water system as necessary to provide for minimum 8" service line in order to improve fire flows in the city;

n. In view of the necessity of providing a higher degree of protection for lives and property in the City's business district as the area continues to develop, the need for and feasibility of establishing a Fire Zone I governing construction standards should be studied and an appropriate recommendation made;

o. In order to provide an enhanced revenue source for the upgrading and expansion of the City's fire protection services commensurate with the expected increase in population and development within the City, the feasibility of a benefit assessment fee structure should be examined. As an alternative, a development fee based on square footage for new construction projects could be adopted to help cover the costs of increased staffing and equipment necessary for serving such new development.

Dam Inundation

a. Require all private, quasi public or governmental projects which could result in increased inundation hazards to prepare environmental reports covering the degree of hazard;

b. Cooperatively, with County Flood Control, Office of Emergency Services, Corp of Engineers, or other appropriate body, assess and define flood protection engineering and construction measures institutable to reduce inundation hazards. Measures such as widening and hardening of existing flood channels or construction of additional channels should be considered;

c. Control development of critical facilities and residences within inundation areas to minimize inundation losses;

d. Advise developers of inundation hazards in areas of potential development;

e. As appropriate, require specific flood control measures to be included in any development to reasonably protect against inundation;

f. Implement appropriate response actions in inundation areas when required by inundation plan upon receipt of warning of pending inundation. Coordinate inundation response planning with the City of Perris Emergency Operations Plan and the overall disaster response programs of the City, as well as with other affected government agencies.

TABLE 3
HAZARD COMPARISON OF NON-EARTHQUAKE-RESISTIVE BUILDINGS

| Simplified Description of Structural Type | Relative Damagability (in order of increasing susceptibility to damage) |
|---|---|
| Small wood-frame structures, i.e., dwellings not over 3,000 sq. ft. and not over 3 stories | 1 |
| Single or multistory steel-frame buildings with concrete exterior walls, concrete floors, and concrete roof. Moderate wall openings | 1.5 |
| Single or multistory reinforced-concrete buildings with concrete exterior walls, concrete walls, and concrete roof. Moderate wall openings | 2 |
| Large area wood-frame buildings and other wood frame buildings | 3 to 4 |
| Single or multistory steel-frame buildings with unreinforced masonry exterior wall panels; concrete floors and concrete roof | 4 |
| Single or multistory reinforced-concrete frame buildings with unreinforced masonry exterior wall panels, concrete floors and concrete roof | 5 |
| Reinforced concrete bearing walls with supported floors and roof of any material (usually wood) | 5 |
| Buildings with unreinforced brick masonry having sand-line mortar; and with supported floors and roof of any material (usually wood) | 7 up |
| Bearing walls of unreinforced adobe, unreinforced hollow concrete block, or unreinforced hollow clay tile | Collapse hazard in moderate shocks |

This table is intended for buildings not containing earthquake bracing, and in general, is applicable to most older construction. Unfavorable foundation conditions and/or dangerous roof tanks can increase the earthquake hazard greatly.

## IV. RELATIONSHIPS TO OTHER GENERAL PLAN ELEMENTS

The Seismic Safety and Safety Elements are the major natural hazards analysis in the General Plan and, as such, have important policy implications for other elements in the Plan. In particular, the Seismic Safety and Safety Elements provide significant information for the Land Use, Housing, Open Space, and Circulation Elements. It is recommended that these Elements be prepared or revised to give specific recognition to the policies adopted in the Seismic Safety and Safety Elements.

The Land Use Element will be influenced most directly by the recommendations to regulate land use in areas of significant natural hazards. The Land Use Element may also recommend land use controls for those areas in which "stacking" or combinations of individual hazard zones result in a high level of overall hazard. Figure 7 shows the effects of "stacking" on various land uses.

The policies of these Elements provide input to the Housing Element primarily by recommending design and construction modifications. The following recommendations pertain directly to the Housing Element:

1. All new construction should conform to the revised Uniform Building Code Earthquake Regulations.

2. Existing high occupancy residential structures found to be seismically vulnerable should be strengthened or replaced or their occupancy level should be reduced.

3. Construction on the 100-year flood plain should provide adequate flood-proofing, if other flood control measures are not implemented.

The Seismic Safety and Safety Element identify certain areas which should be considered for open space designation a part of the Open Space Element. These areas include lands designated as high landslide risk areas, areas of high liquefaction potential, the 100-year flood plain, and areas subject to inundation immediately beneath major dams.

| BUILDING TYPE/LAND USE | | SEISMIC, SECONDARY SEISMIC, AND FLOOD HAZARDS ZONES (SHOWN ON PLATES I AND II.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1/HMZ | 2/IA | IB | IC | ID | IE | IIA | IIB | IIC | IID | IIE | IIIA | IIIB | IIIC | IIID | IIIE | IVA | IVB | IVC | IVD | IVE | VA | VB | VC | VD | VE | 3/H+ | H- | M | L | N | 4/LL | L | 5/100F |
| EMERGENCY FACILITIES | Hospitals, Fire Stations, Police Stations, Civil Defense Headquarters, Lifeline Systems for Gas, Electric, Water, Telephone, Emergency Broadcast Systems, Ambulance Services, Power Plants (Nuclear, Fossil Fuel), Dams, Reservoirs. | | | | | | | ○ | ⊘ | | ⊘ | | ⊘ | ⊗ | | ⊗ | | | | | | | | | | | | | | ○ | ○ | ● | | | ⊗ |
| CRITICAL FACILITIES | Schools, Theaters, Auditoriums, Utility Substations, Sewage Treatment Plants, Waterworks, Local Gas and Electric Lines, Major Highways, Bridges, Tunnels, Aqueducts, Pipe Lines, Public Service Facilities, Public Assembly-Capacity of 100 or more. | | | | | | | ○ | ○ | | ⊘ | | ⊘ | ⊘ | | ⊗ | | | | | | | | | | | | | | ○ | ● | ● | | | ⊘ |
| NORMAL FACILITIES | Category 1<br>Heavy Industrial, Office Buildings, Commercial Centers, Hotels and Motels, Banks and Financial Establishments, High Density Residential, Service Stations, Healthcare Clinics. | | | | | | | ● | ○ | | ○ | | ○ | ⊘ | | ⊘ | | | | | | | | | | | | | | ○ | ● | ● | | | ○ |
| NORMAL FACILITIES | Category 2<br>Light Industrial, Low Density Residential, Warehousing and Storage, Agriculture, Parks. | | | | | | | ● | ● | | ○ | | ● | ○ | | ○ | | | | | | | | | | | | | | ○ | ● | ● | | | ○ |

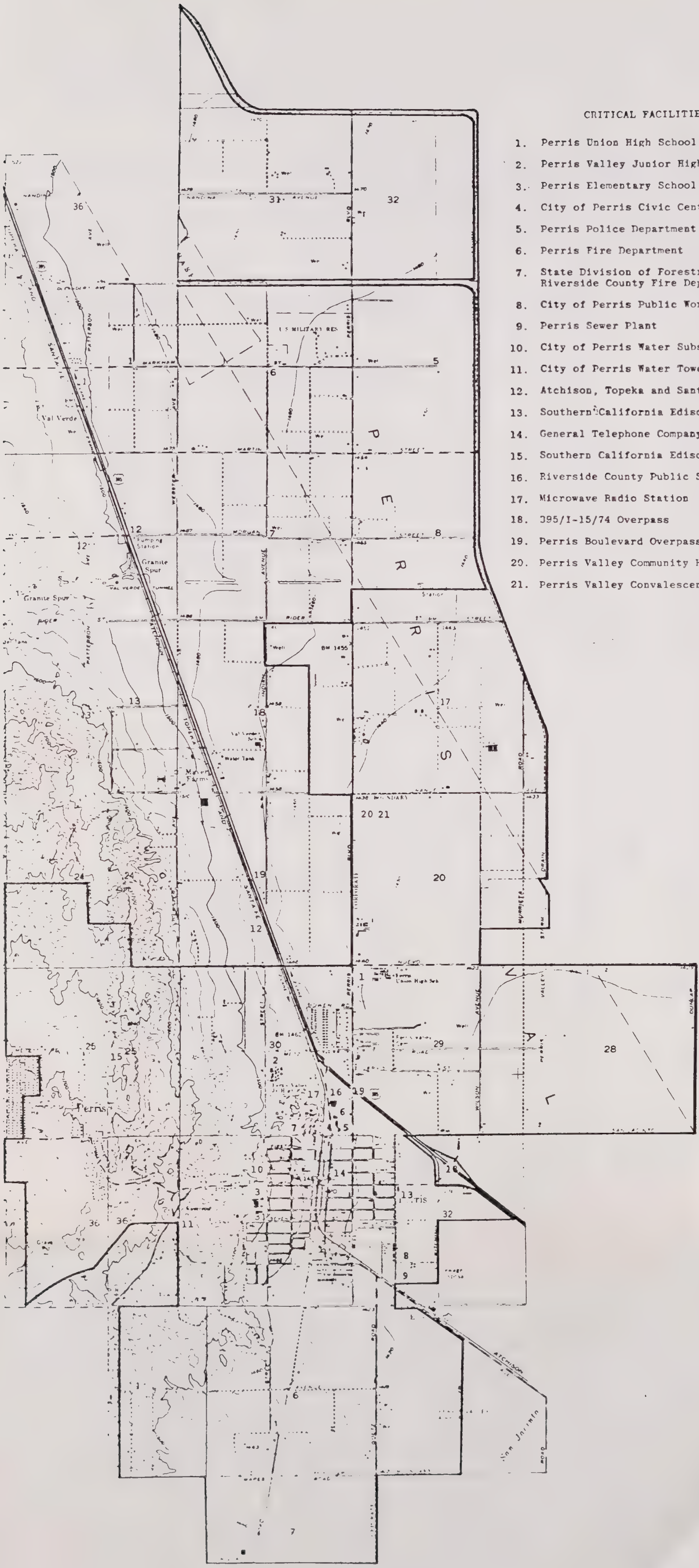
Explanation

● Generally Suitable ○ Provisionally Suitable ⊘ Generally Unsuitable ⊗ Restricted

Notes: This Chart is for General Land Use Planning only. Suitability for specific uses on a particular site must be confirmed by further investigation. An area evaluated as generally unsuitable for a particular use does not necessarily preclude the use if no other suitable alternative sites are available, provided that all potential hazards can be mitigated. In the case of restricted areas, mitigation is extremely difficult and in some instances, impossible.

1/Hazard Management Zone 2/Ground shaking zones 3/Landslide risk zones 4/Liquefaction potential zones 5/100-year flood zone

Figure 7. Land Use/Risk Matrix




CRITICAL FACILITIES

1. Perris Union High School
2. Perris Valley Junior High School
3. Perris Elementary School
4. City of Perris Civic Center
5. Perris Police Department
6. Perris Fire Department
7. State Division of Forestry/ Riverside County Fire Department
8. City of Perris Public Works Department
9. Perris Sewer Plant
10. City of Perris Water Substation
11. City of Perris Water Tower
12. Atchison, Topeka and Santa Fe Railway
13. Southern California Edison Company
14. General Telephone Company
15. Southern California Edison Substation
16. Riverside County Public Services Offices
17. Microwave Radio Station
18. 395/I-15/74 Overpass
19. Perris Boulevard Overpass
20. Perris Valley Community Hospital
21. Perris Valley Convalescent Hospital

The Circulation Element should recognize that the transportation network north of Perris will be hard hit in the event of a major earthquake or flood. An earthquake will affect primarily freeway overpasses, road bridges, and railroad grade crossings. The effects expected will be similar to what occurred in the Sylmar-San Fernando Valley area of Southern California in the 1971 earthquake. The response spectra presented in the Technical Section of the Seismic Safety Element should be used by structural engineers in the evaluation of existing freeway overpasses and other important grade separations. New construction of bridges, overpasses, and other grade crossings should also utilize seismic response design criteria.

In the event of a 100-year flood, Highway 395 which traverses north of the City can expect to be inundated. This is expected to have an important impact on potential evacuation of the area, and alternate evacuation measures should be planned.

# APPENDIX A

## Earthquake Safety Procedures

# EARTHQUAKE SAFETY PROCEDURES

## Before An Earthquake

1. Potential earthquake hazards in the home should be removed or corrected. Top-heavy objects and furniture, such as bookcases and storage cabinets, should be fastened to the wall and the largest and heaviest objects placed on lower shelves. Water heaters and other appliances should be firmly bolted down, and flexible connections should be used whenever possible.

2. Supplies of food and water, flashlight, a first-aid kit, and a battery-powered radio should be set aside for use in emergencies. Of course, this is advisable for other types of emergencies, as well as for earthquakes.

3. One or more members of the family should have a knowledge of first aid procedures because medical facilities nearly always are overloaded during an emergency or disaster, or may themselves be damaged beyond use.

4. All responsible family members should know what to do to avoid injury and panic. They should know how to turn off the electricity, water, and gas; they should know the locations of the main switch and valves. This is particularly important for teenagers who are likely to be alone with smaller children.

5. It is most important for a resident of California to be aware that this is "earthquake country" and that earthquakes are most likely to occur again where they have occurred before. Building codes that require earthquake-resistant construction should be vigorously supported and, when enacted into law, should be rigorously enforced. If effective building codes and grading ordinances do not exist in your community, support their enactment.

## During An Earthquake

1. The most important thing to do during an earthquake is to remain calm. If you can do so, you are less likely to be injured. If you are calm, those around you will have a greater tendency to stay calm, too. Make no moves or take no action without thinking about the possible consequences. Motion during an earthquake is not constant; commonly, there are a few seconds between tremors.

2. If you are inside a building, stand in a strong doorway or get under a desk, table, or bed. Watch for falling plaster, bricks, light fixtures, and other objects. Stay away from tall furniture, such as china cabinets, bookcases, and shelves. Stay away from windows, mirrors, and chimneys. In tall buildings, it is best to get under a desk if it is securely fastened to the floor, and to stay away from windows or glass partitions.

3. Do not rush outside. Stairways and exits may be broken or may become jammed with people. Power for elevators and escalators may have failed. Many of the 115 persons who perished in Long Beach and Compton in 1933 ran outside only to be killed by falling debris and collapsing chimneys. If you are in a crowded place such as a theater, athletic stadium, or store, do not rush for an exit because many others will do the same thing. If you must leave a building, choose your exit with care and, when going out, take care to avoid falling debris and collapsing walls or chimneys.

4. If you are outside when an earthquake strikes, try to stay away from high buildings, walls, power poles, lamp posts, or other structures that may fall. Falling or fallen electrical power lines must be avoided. If possible, go to an open area away from all hazards but do not run through the streets. If you are in an automobile, stop in the safest possible place, which, of course, would be an open area, and remain in the car.

After An Earthquake

1. After an earthquake, the most important thing to do is to check for injuries in your family and in the neighborhood. Seriously injured persons should not be moved unless they are in immediate danger of further injury. First aid should be administered, but only by someone who is qualified.

2. Check for fires and fire hazards. If damage has been severe, water lines to hydrants, telephone lines, and fire alarm systems may have been broken; contacting the fire department may be difficult. Some cities, such as San Francisco, have auxiliary water systems and large cisterns in addition to the regular system that supplies water to fire hydrants. Swimming pools, creeks, lakes and fish ponds are possible emergency sources of water for fire fighting.

3. Utility lines to your house - gas, water, and electricity - and appliances should be checked for damage. If there are gas leaks, shut off the main valve which is usually at the gas meter. Do not use matches, lighters, or open-flame appliances until you are sure there are no gas leaks. Do not use electrical switches or appliances if there are gas leaks, because they give off sparks which could ignite the gas. Shut off the electrical power if there is damage to the wiring; the main switch usually is in or next to the main fuse or circuit breaker box. Spilled flammable fluids, medicines, drugs, and other harmful substances should be cleaned up as soon as possible.

4. Water lines may be damaged to such an extent that the water may be off. Emergency drinking water can be obtained from water heaters, toilet tanks, canned fruits and vegetables, and melted ice cubes. Toilets should not be flushed until both the incoming water lines and outgoing sewer lines have been checked to see if they are open. If electrical power is off for any length of time, plan to use the foods in your refrigerator and freezer first before they are spoiled. Canned and dried foods should be saved until last.

5. There may be much shattered glass and other debris in the area, so it is advisable to wear shoes or boots and a hard hat if you own one. Broken glass may get into foods and drinks. Liquids can be either strained through a clean cloth such as a handkerchief or decanter. Fireplaces, portable stoves, or barbecues can be used for emergency cooking but the fireplace chimney should be carefully checked for cracks and other damages before being used. In checking the chimney for damage, it should be approached cautiously, because weakened chimneys may collapse with the slightest of aftershocks. Particular checks should be made of the roof line and in the attic because unnoticed damage can lead to a fire. Closets and other storage areas should be checked for objects that have been dislodged or have fallen, but the doors should be opened carefully because of objects that may have fallen against them.

6. Do not use the telephone unless there is a genuine emergency. Emergencies, and damage reports, alerts, and other information can be obtained by turning on your radio. Do not go sightseeing; keep the streets open for the passage of emergency vehicles and equipment. Do not speculate or repeat the speculations of other - this is how rumors start.

7. Stay away from beaches and other waterfront areas where seismic sea waves (tsunamis), sometimes called "tidal waves", could strike. Again, your radio is the best source of information concerning the likelihood that a seismic sea wave will occur. Also stay away from steep landslide-prone areas if possible, because aftershocks may trigger a landslide or avalanche, especially if there has been a lot of rain and the ground is nearly saturated. Also stay away from earthquake-damaged structures. Additional earthquake shocks known as "aftershocks" normally occur after the main shock, sometimes over a period of several months. These are usually smaller than the main shock but they can cause damage, too, particularly to damaged and already weakened structures.

8. Parents should stay with young children who may suffer psychological trauma if parents are absent during the occurrence of aftershocks.

9. Cooperate with all public safety and relief organizations. Do not go into damaged areas unless authorized; you are subject to arrest if you get in the way of, or otherwise hinder, rescue operations. Martial law has been declared in a number of earthquake disasters. In the 1906 disaster in San Francisco, several looters were shot.

10. Send information about the earthquake to the Seismological Field Survey to help earth scientists understand earthquakes better.

# APPENDIX B

## Summary Of Significant Court Decisions And Legislation

SUMMARY OF SIGNIFICANT COURT DECISIONS
AND LEGISLATION

(Source: Urban Geology Master Plan For California, 1973)

In recent years there have been many attempts by government to reduce losses from geologic hazards. The following summaries are some of the more important ones.

Court Decisions

1. Sheffet decision (Los Angeles Superior Court Case No. 32487): Declared that a public entity is liable for damages to adjacent property resulting from improvements planned, specified or authorized by the public entity in the exercise of its governmental power. (The State Supreme Court refused to rehear this decision, which establishes a judicial precedent.)

2. L.A. County Superior Court (Case No. 684595 and consolidated cases): This decision found the County liable for damages which may have resulted from roadwork and the placement of fill by the County. This case was in regard to the Portuguese Bend landslide, Palos Verdes Hills, Los Angeles County, California.

3. City of Bakersfield vs Miller (48 Cal. Rptr. 889), heard in the State Supreme Court 1966: This decision affirms that the city may declare an older structure not in compliance with the newly adopted Uniform Building Code to be a public nuisance. Further, the city may enforce abatement of the nonconforming condition even though to do so may require the building to be demolished.

4. Burgess vs. Conejo Valley Development Co. (Connor vs. Great Western Savings and Loan Association) (73 Cal. Rptr. 369) heard in the State Supreme Court in 1968, concerning damage to tract homes from expansive soil in Thousand Oaks, Ventura County: This decision affirmed that the home buyer, both first buyer and all subsequent ones, has the right to protection from negligent construction practice leading to damage. In this case, neither contractor, county inspectors, nor representatives of the major lending institution acted to ascertain expansive soil conditions, or to prevent damage from them.

5. Oakes vs. The McCarthy Co. (California Appellate Reports, 2d Series, 267, 1968) the court held that in the Palos Verdes area, Los Angeles County, a developer and soils engineering company could be liable in negligence for damages to a home resulting from using improper (clay) fill material and improperly compacting that fill so that earth movement resulted. Also, the court awarded punitive damages against the developer for fraudulent concealment of material facts concerning the property, i.e., failure to volunteer to the prospective buyer that the house was built upon fill.

Legislation

PUBLIC RESOURCES CODE

Section 660-662 and 2621-2625: These sections require the State Geologist to delienate special studies zones encompassing potentially and recently active fault traces. It requires cities and counties to exercise specified approval authority with respect to real estate developments of structures for human occupancy within such delineated zones.

Section 2700-2708: These sections require the Division of Mines and Geology to purchase and install strong-motion instruments (to measure the effects of future earthquakes) in representative structure and geologic environments throughout the state.

Section 2750: Establishes a state mining and minerals policy which, among other things, encourages wise use of mineral resources.

EDUCATION CODE

Section 15002.1: This section requires that geological and soils engineering studies be conducted on all new school sites and on existing sites where deemed necessary by the Department of General Services.

Section 15451-15466: These sections constitute the Field Act and require that public schools be designed for the protection of life and property. These sections, enacted in 1933 after the Long Beach earthquake, are enforced by the State Office of Architecture and Construction in accordance with regulations contained in Title 21 of the California Administrative Code.

HEALTH AND SAFETY CODE

Sections 15000 et seq.: These sections require that geological and engineering studies be conducted on each new hospital or additions affecting the structure on an existing hospital, excepting therefrom one story Type V buildings 4000 sq. ft. or less in area.

Sections 19100-19150: These sections constitute the Riley Act and require certain buildings to be constructed to resist lateral forces, specified in Title 24 California Administrative Code.

Sections 17922, 17951-17958.7: These sections require cities and counties to adopt and enforce the Uniform Building Code, including a grading section (chap. 70), a minimum protection against some geologic hazards.

BUSINESS AND PROFESSIONAL CODE

Section 7800-7887: These sections provide for the registration of geologists and geophysicists, and the certification of certain geologists in the specialty of engineering geology.

Section 11010: This section requires that a statement of the soil conditions be prepared and needed modifications be carried out in accordance with the recommendations of a registered civil engineer.

Section 11100-11629: These sections require studies in subdivisions to evaluate the possibilities of flooding and unfavorable soils.

GOVERNMENT CODE

Section 8589.5: This section requires that inundation maps and emergency evacuation plans be completed for areas subject to inundation by dam failure.

Section 65300-65302.1: These sections require that each city and county shall adopt the following elements:

Seismic Safety Element consisting of the identification and appraisal of seismic hazards including an appraisal of landsliding due to seismic events.

Conservation element including the conservation, development and utilization of minerals.

Safety element including protection of the community from geologic hazards including mapping of know geologic hazards.

APPENDIX C

General Characteristics Of Earthquakes

## A. GENERAL CHARACTERISTICS OF EARTHQUAKES

### 1. The Source Of Earthquakes

Earth scientists are generally agreed that earthquakes originate as the result of an abrupt break or movement of the rock in the relatively brittle crust of the earth. The earthquake is the effect of the shock waves generated by the break, much the same as sound waves (a noise) are generated by breaking a brittle stick. If the area of the break is small and limited to the deeper part of the crust, the resulting earthquake will be small. However, if the break is large and extends to the surface, then the break can result in a major earthquake.

These breaks in the earth's crust are called faults. In California, faults are extremely common, and vary from the small breaks of an inch or less that can be seen in almost any road-cut, to the larger faults such as the San Andreas on which movement over many millions of years has amounted to hundreds of miles. In addition to the size of faults, their "age" is also important. Many large faults have not moved for millions of years; they are considered "dead" or "inactive." They were probably the source of great earthquakes millions of years ago but are not considered dangerous today.

Since faults vary as to the likelihood of their being the source of an earthquake, considerable effort has, and is continuing to be expended by geologists and seismologists to determine and delineate the faults likely to generate significant earthquakes. These faults are classified generally as follows:

(1) An historically active fault is one which is known to have slipped during historical time, or one which is associated with an alignment of earthquake epicenters. In California this "historical time" span is limited to approximately 150 years.

(2) An active fault is one that has moved in the recent geologic past, and that can be expected to move again in the foreseeable future. The "recent geologic past" is generally interpreted to include recent geologic time; a period of approximately 10,000 years. However, a precise definition of "active fault," such as is needed where the term is included in legal documents, is still a matter of considerable debate.

(3) A potentially active fault is one that lacks the criteria to be classified as active, but which must be considered suspect because of offset of Quaternary sediments (up to approximately 2 million years old) or the presence of scattered earthquake epicenters. This classification, may be applied as much due to lack of definitive data as to the presence of data that definitely precludes recent movement.

2. Describing An Earthquake

Several terms are used to describe the location, "size," and effects of an earthquake. A clear understanding of the meaning of these terms and their limitations is essential to an understanding of the results of the investigation.

The location of an earthquake is generally given as the epicenter of the earthquake. This is a point on the earth's surface vertically above the hypocenter or focus of the quake. The latter is the point from which the shock waves first emanate. However, as discussed, above, earthquakes originate from faults. These are surfaces not points, so the hypocenter is only one point on the surface (or volume) that is the source of the earthquake.

Magnitude describes the size of the earthquake itself. Technically, it is defined as the logarithm of the maximum amplitude recorded on a standard seismograph at 100 kilometers (62 miles) from the epicenter. The most important part of this definition is that it is a logarithmic scale and an increase of one in magnitude (e.g., magnitude 5.0 to 6.0) represents an increase of 10 in the amplitude of the recorded waves. It should also be noted that the magnitude of an earthquake is determined at a considerable distance from the epicenter of the earthquake, and that it is based on ground displacement rather than ground acceleration.

Intensity describes the degree of shaking in terms of the damage at a particular location. The scale used today is the Modified Mercalli Scale, and is composed of 12 categories (I to XII) of damage as described in Table 1. The Roman numerals are used to emphasize that the units in the scale are descrete categories rather than a continuous numerical sequence as is the magnitude scale, It is important to remember that intensity is a very general description of the effects of an earthquake, and depends not only on the size of the quake and the distance to its center but also on the quality of the construction that has been damaged and the nature of local ground conditions.

3. Occurrence And Recurrence Of Earthquakes

Earthquakes have had in the past a certain occurrence in space and time. These occurrences may or may not set certain patterns that can form the basis for predicting their occurrence in the future. When such occurrences are analyzed in time, certain characteristics may statistically recur at definite intervals. If it can be shown that a particular magnitude earthquake recurs on a fault on the average of a certain number of years, this number can be said to be the recurrence interval for the magnitude. If the interval of time is set (e.g., a 100-year period), then earthquakes of a particular magnitude will recur a certain number of times in the specified period.

In California, as in most large areas, small earthquakes occur much more often than large earthquakes. Also, there is a fairly definite pattern in that the logarithm of the number of events of a particular magnitude that have occurred in the past is approximately proportional to the magnitude of those events. This relationship appears to apply to larger areas such as California and western Nevada, some smaller areas such as the Los Angeles Basin, and to some faults such as the Newport-Inglewood. However,

TABLE 1.
MODIFIED MERCALLI INTENSITY SCALE OF 1931
(from United States Earthquakes)

| Intensity | Description of Damage |
|---|---|
| I | Not felt except by a very few under specially favorable circumstances. (I Rossi-Forel Scale) |
| II | Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel Scale) |
| III | Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale) |
| IV | During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale) |
| V | Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale) |
| VI | Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale) |
| VII | Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerably in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale) |
| VIII | Damage slight in specially designed structures; considerable in ordinary, substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII to IX Rossi-Forel Scale) |
| IX | Damage considerable in specially designed structures; well-designed, frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX Rossi-Forel Scale) |

TABLE 1.
MODIFIED MERCALLI INTENSITY SCALE OF 1931
(from United States Earthquakes)
(continued)

| Intensity | Description of Damage |
|---|---|
| X | Some well-built wooden structures destroyed; most masonry and frame structures destroyed with their foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale) |
| XI | Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. |
| XIII | Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air. |

In California, as in most large areas, small earthquakes occur much more often than large earthquakes. Also, there is a fairly definite pattern in that the logarithm of the number of events of a particular magnitude that have occurred in the past is approximately proportional to the magnitude of those events. This relationship appears to apply to larger areas such as California and western Nevada, some smaller areas such as the Los Angeles Basin, and to some faults such as the Newport-Inglewood. However, this relationship does not apply to all faults, and it should be applied to small areas, such as cities or individual sites, with great care.

## B. ENGINEERING CHARACTERISTICS OF EARTHQUAKES

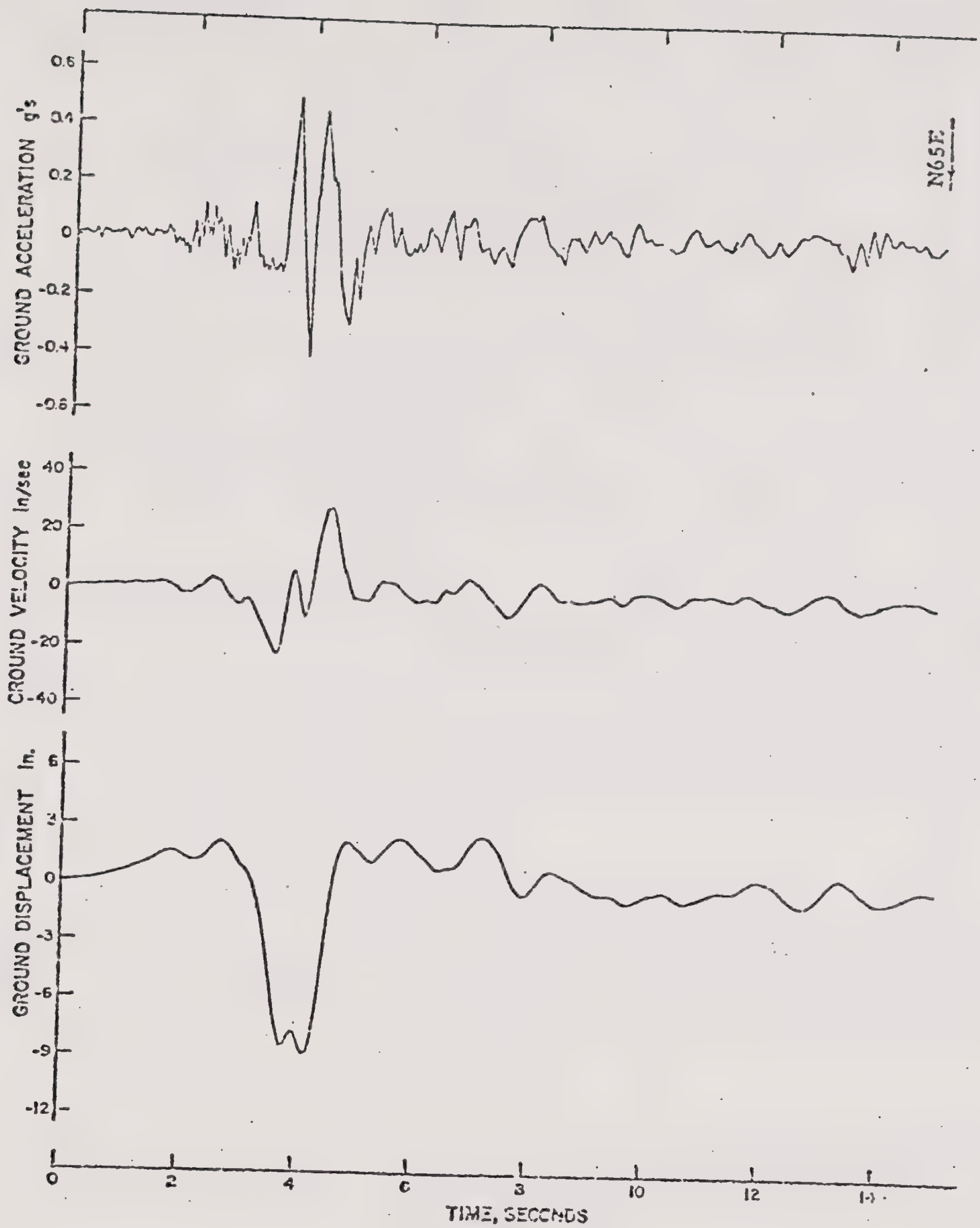
The data of seismologists and geologists are, in general, not applicable to the engineering design of earthquake-resistant structures. The seismograph, for example, is a very sensitive instrument designed only to record earthquakes at great distances. A level of shaking that would be meaningful to an engineer in designing a building would put most seismographs completely off-scale.

As a result, it has been necessary to design and install special instruments to record the strong motion of earthquakes that are of interest to the engineer in the design of earthquake-resistant structures. The first such instruments, principally accelerographs and seismoscopes, were installed by the U.S. Coast and Geodetic Survey in the late 1920's and the 1933 Long Beach earthquake was the first real test of the system. The motions were apparently stronger than expected, and the accelerograph record from Long Beach itself has never been adequately deciphered. Since that time, the instrumentation and analytical techniques have been continuously improved, and many excellent records have been obtained of the more recent strong earthquakes.

The following sections are a brief introduction to the concepts, data, and application of strong-motion records. The science is relatively young, and tends to grow in bursts following the recording of a damaging earthquake.

### 1. <u>Acceleration, Velocity, and Displacement</u>

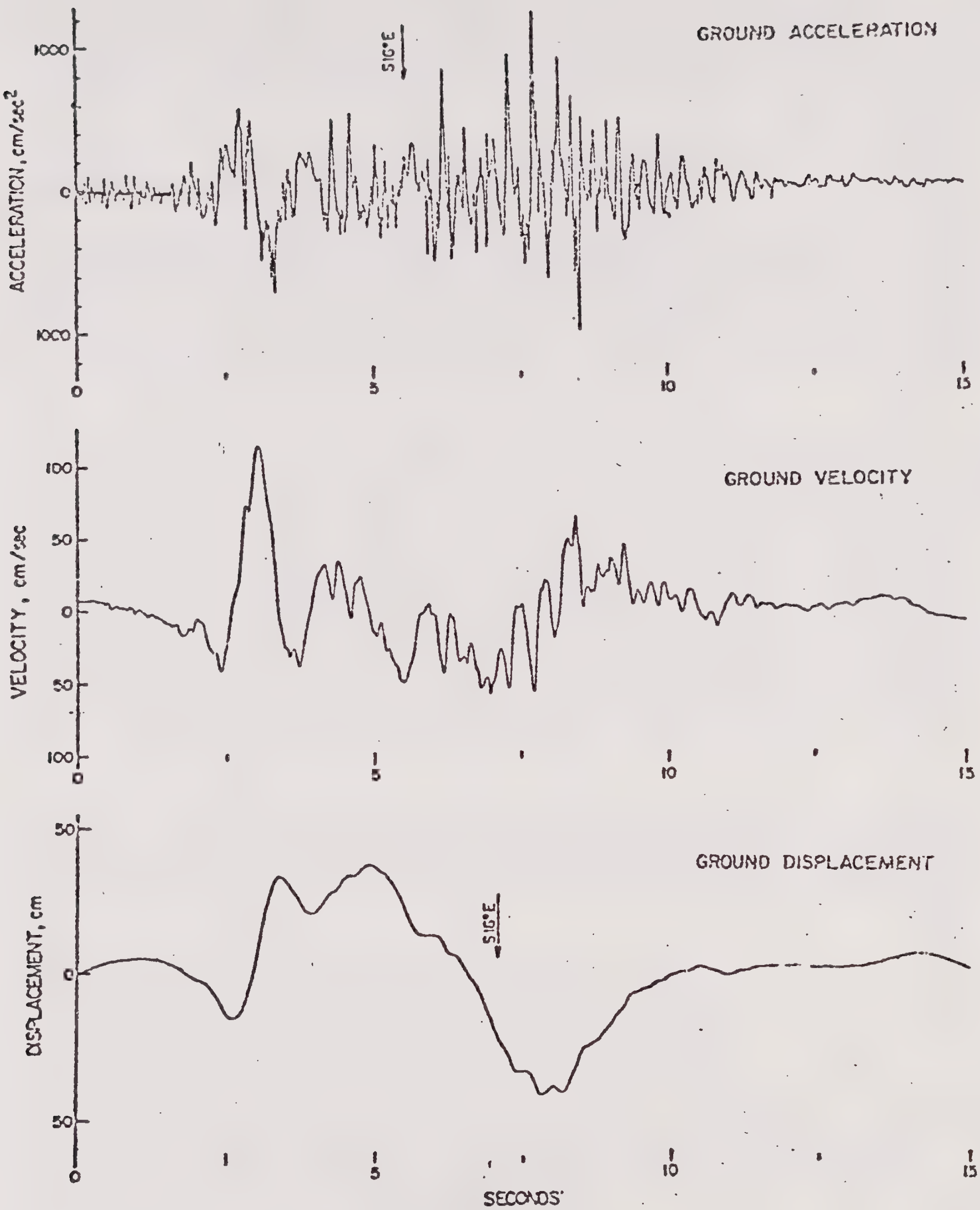
The accelerograph is a short-period instrument (in contrast to the seismograph), and measures the acceleration of the ground or the structure on which it is mounted. Figure 1 shows the ground acceleration recorded just a few hundred feet from the fault during the 1966 Parkfield earthquake. The velocity and displacement curves have been derived from it by integration. It is a particularly good example of the relationships of these three parameters of motion because of the relatively "clean", single-displacement pulse that corresponds to two velocity peaks and four acceleration peaks. Figure 2 shows the more typically complex record of the San Fernando earthquake as recorded at Pacoima Dam. Neither of the two, however, are typical records in terms of accelerations recorded. The Pacoima record shows the largest acceleration recorded to date (1.25g), and the Parkfield record (0.5g) was the largest before the San Fernando earthquake.




Station 2 N65E Motion.

Figure 1.

from Housner & Trifunac, 1967




Acceleration, velocity and displacement in the S16°E direction during the main event of the San Fernando earthquake of February 9, 1971, 06:00 (PST).

Figure 2.

from Trifunac & Hudson, 1971

It should also be noted that accelerographs normally record three components; two in the norizontal plane at right angles to each other, and one vertical. Only one component is shown in each of the two examples.

Maximum acceleration is one of the basic parameters describing ground shaking, and has been the one most often requested by agencies such as FHA in determining the earthquake hazard to residential structures. It is particularly important for "low-rise" construction (up to 3 to 5 seconds) and other structures having natural periods in the range of 0.3 - 0.5 seconds or less.

2. Frequency Content - Fourier and Response Spectra

The frequency content of the ground motion is particularly important for the intermediate and higher structures. The problem can be compared to pushing a child in a swing. If the pushes are timed to coincide with the natural period of the swing, then each push makes the swing go higher. However, if the timing is not right, then most of the push is lost "fighting" the natural period of the swing. The situation is similar during earthquakes. Structures have certain periods of vibration. If the pulses of the earthquake match the natural period of the structure, even a moderate earthquake can cause damaging movement. However, if the match is poor, the movement and resulting damage will be much less.

Two methods are commonly used to analyze and display the frequency content of an earthquake. A Fourier analysis is a common mathematical method of deriving the significant frequency characteristics of a time-signal such as the record of an earthquake. The results of the analysis are an amplitude term and a phase term. The amplitude is normally plotted against the period for that amplitude to give a Fourier amplitude spectrum for the range of frequencies that are of interest. Since the mathematical procedure is basically an integration of acceleration with time, the Fourier amplitude has the units of velocity.

A response spectrum is derived by a similar mathematical process, but is slightly different in concept. It represents the maximum response of a series of oscillators, having particular periods and damping, when subjected to the shaking of the earthquake. The result is also expressed in terms of velocity with the particular nomenclature depending on the precise method used to derive the spectrum.

The Fourier spectrum can be generally described as the energy available to shake structures having various natural frequencies. The response spectrum gives the effect, in maximum velocity, of this available energy on simple structures having various frequencies and damping. At zero damping the two are very similar. Figure 3 shows a plot of both the Fourier spectrum and the response spectrum with zero damping for the Taft earthquake of 1952. Figure 4 shows the response spectrum for the Parkfield record (Figure 1) for several levels of damping.

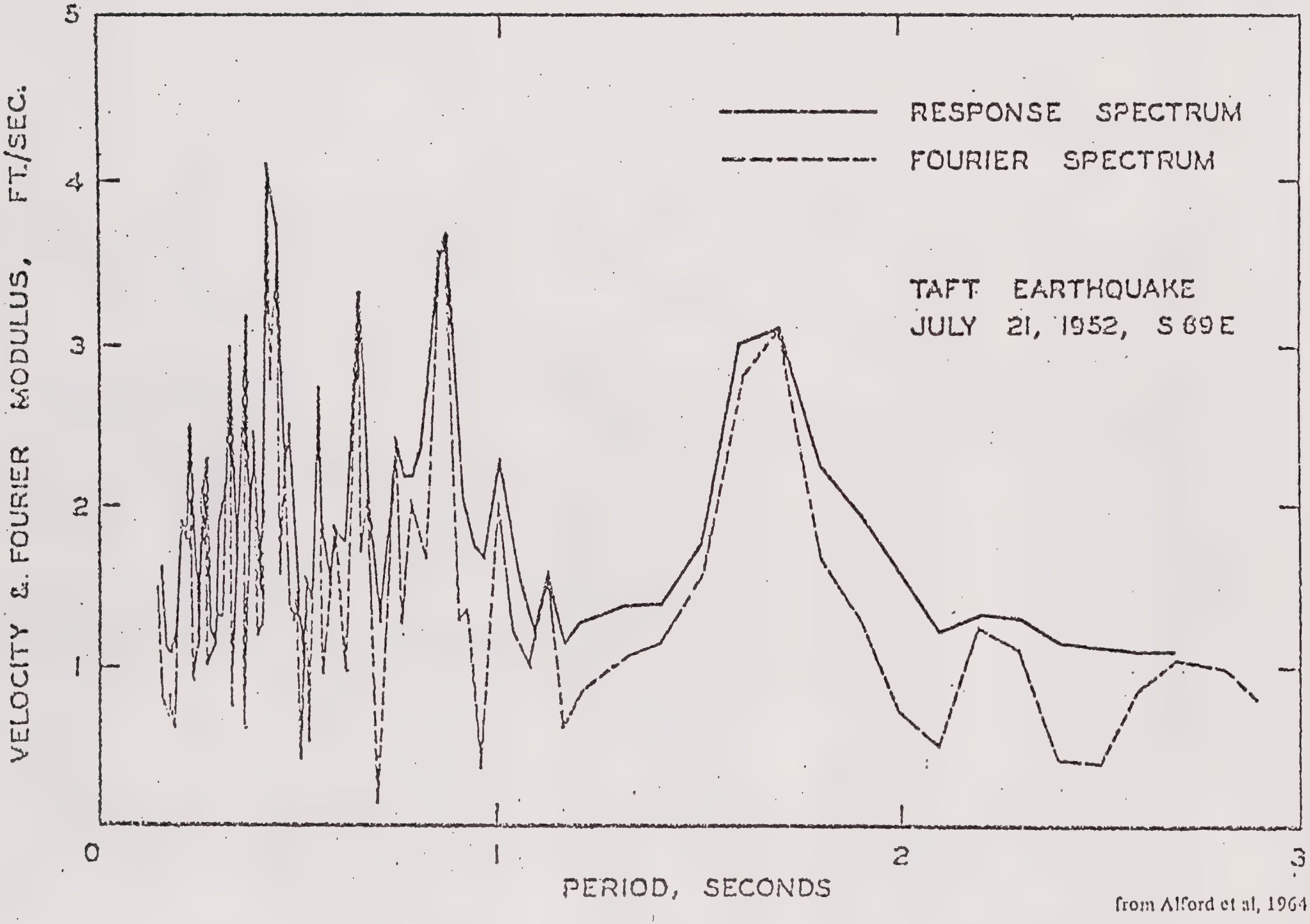
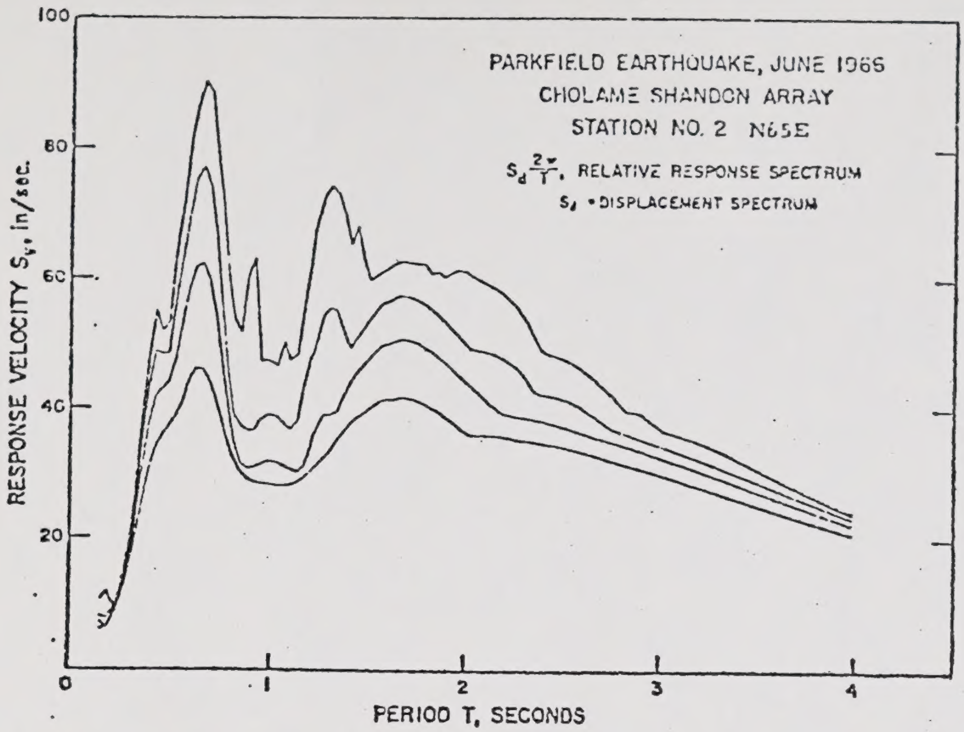

RESPONSE SPECTRUM
FOURIER SPECTRUM
TAFT EARTHQUAKE
JULY 21, 1952, S 69 E
VELOCITY & FOURIER MODULUS, FT./SEC.
5
4
3
2
1
0
1
2
3
PERIOD, SECONDS
from Alford et al, 1964

Figure 3




Response Spectra, Station 2-N65E. The curves are for 0, 2, 5 and 10% damping

Figure 4 from Housner & Trifunac, 1967

3. Near-Surface Amplification

The shock waves of an earthquake radiate outward from the source (i.e., the slipped fault) through the deeper and relatively more dense parts of the earth's crust. In this medium the waves travel at high velocity and with relatively low amplitude. However, as they approach the surface, the velocity of the medium decreases and may become quite variable if layers of different rock types are present. The overall effect is generally an amplification of the wave or of certain frequencies within the spectrum of the wave.

The most consistently applicable effect is the increase in wave amplitude that accompanies the decrease in velocity. This relationship can be compared to laws of mechanics that require the conservation of energy and momentum. In the case of earthquake waves, the energy of velocity is transferred to energy of wave amplitude when the velocity decreases.